PTEMBER 1961
UME 4 • NUMBER 9

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- Cuccia & Wolkstein — Recent Advances In Low-Noise Traveling-Wave Tubes — Part II
- Reed — Long Line Effect In Pulse Compression Radar

the microwave journal

ROBT H MAIER-SR ENGR
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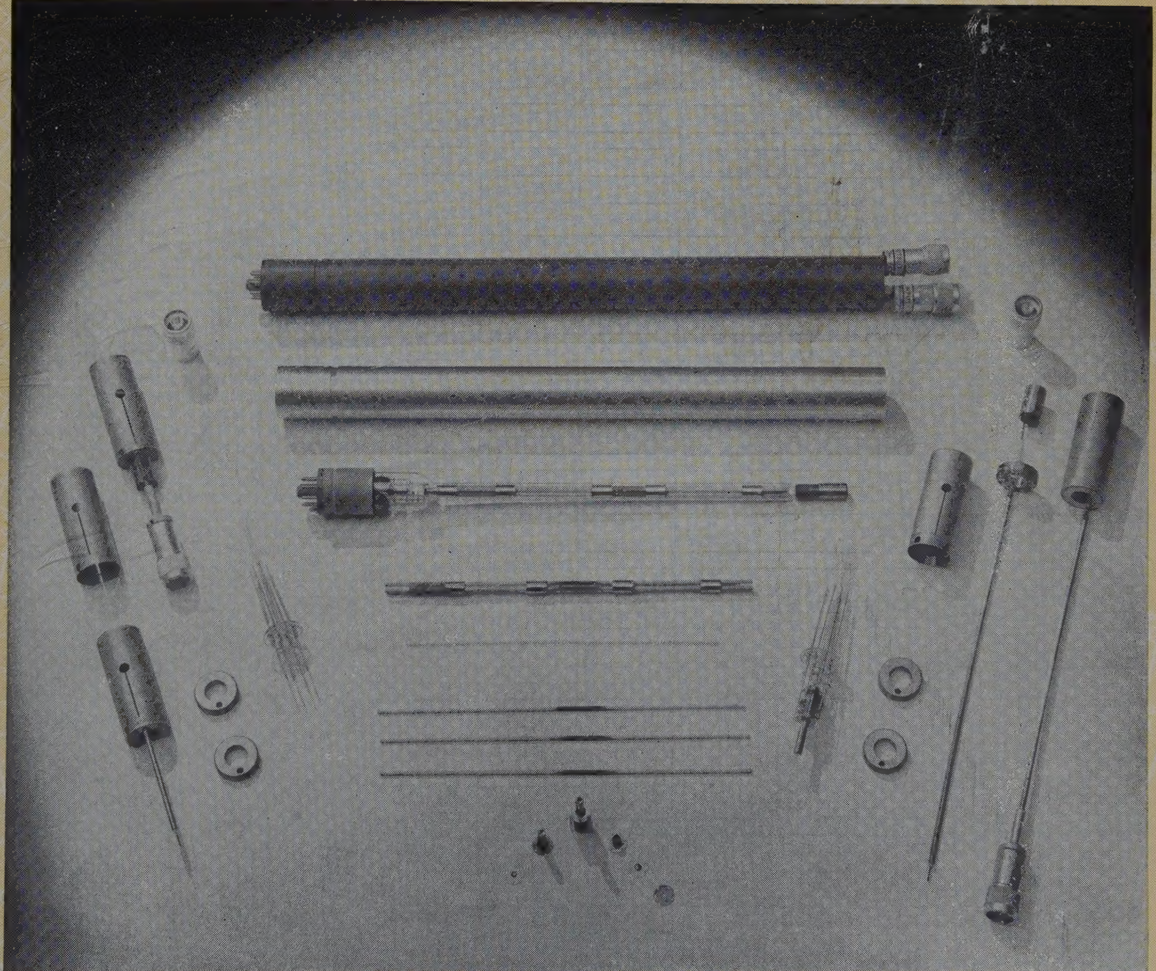

This Issue . . . An Accurate Attenuation Measuring System With Great Dynamic Range

COAXIAL TEST EQUIPMENT

INSTRUMENT	MODEL NO.	FREQ KMC/SEC	PRICE	COMMENT
SLOTTED SECTIONS	N101A N101B *V101A *V101B N110A	1.00- 4.00 4.00-10.00 1.00- 4.00 1.00- 4.00 0.20- 4.00	$470.00 $440.00 $470.00 $470.00 $550.90	Type N or C adapter connector supplied for N101A, B
FERRITE ISOLATORS	N157A	1.00- 4.00	$390.00	
FIXED ATTENUATORS	N180A,B,C,D	1.00-11.00	$ 42.00	3, 6, 10, 20 db
TUNABLE PROBES	B200A B202A	1.00-12.40 0.35- 1.40	$145.00 $225.00	1N23B supplied 1N21B supplied
DETECTOR MOUNTS Tunable Untuned	N200A N210A **N210B	1.00-12.40 0.10-10.00 0.10-10.00	$145.00 $ 50.00 $ 55.00	1N23B crystal supplied
THERMISTOR MOUNTS Broadband Temp Compensated	N215A N217A	0.50-10.50 0.50-10.50	$ 75.00 $140.00	Z215L element supplied
THERMISTOR HEAD	N218A	0.01-10.00	$145.00	Used with Model B831A
DOUBLE STUB TUNER	N300A	1.00-10.00	$ 90.00	
SLIDE SCREW TUNER	N311A	1.00-10.00	†	
FREQUENCY METERS, DIRECT READING	N410A N414A	1.00- 4.00 4.00-11.00	$495.00 $495.00	Accuracy 0.08% Accuracy 0.10%
DIRECTIONAL COUPLERS (20 DB)	N616D N617D	0.25- 1.00 1.00- 4.00	$160.00 $150.00	
KLYSTRON TUBE MOUNT	N761A		$ 95.00	Z761P cable not supplied
KLYSTRON TUBE MOUNT	Z762B		$145.00	Z762P cable supplied

*Mating coax dim. 7/8" all others 3/8"

**Model N210B has built in DC return.

†Price will be furnished on request.

WAVEGUIDE TEST EQUIPMENT

Y .622x.311	K* .420x.170	U* .280x.140	Q .224x.112	M .148x.074	E .122x.061	F .080x.040	G .051x.0255	FXR SERIES PREFIX WAVEGUIDE SIZE IN INCHES (I.D.)
12.40x18.00	18.00-26.50	26.50-40.00	33.00x50.00	50.00-75.00	60.00x90.00	90.00-140.00	140.00x220.00	**FREQUENCY RANGE IN KMC/SEC**
Y102A $545	K102A $545	U102A $545	Q103A $1100	M103A $995	E103A $1650	F105A $1400	G105A $1400	**SLOTTED SECTIONS** Fixed W.C.
Y115A			TYPE Z116A CARRIAGE $160					Interchangeable W.C.
			Q151A $110	M151A $100	E151A $190			**ATTENUATORS** Flap
Y155A $ 90	K155A $135	U155A $170						Semiprecision
						F163A $975	G163A $975	Precision Calibrated
Y164A $275	K164A $425	U164A $450	Q164A $825	M164A $800	E164A $1200			Precision Direct Reading
								Fixed
Y175A $115	K175A $240	U175A $250	Q175A $475	M175A $425	E175A $675	(Values to 30DB)		Fixed Precision
								40DB Step
Y157A $220	K157A $240							**FERRITE ISOLATORS**
Y205B $175	K205B $175	U205B $200 U206B $200	Q206B $210	M208A $325 M206B $210	E208A $400 E206C $350	F208A $400	G208A $400	**CRYSTAL DETECTOR MOUNTS** Tuneable
Y212A $ 80	K212A $ 80	U212A $ 80						Fixed
								MATCHED BOLOMETER MOUNTS
Y216A $110	K216A $150	U216S $270						**THERMISTOR MOUNTS**
Y218A $210	K218A $250	U218S $400						**THERMISTOR HEADS TEMPERATURE COMPENSATED**
Y311A $130				M311A $195				**TUNERS** Slide screw
Y312C $135	K312C $155	U312B $170	Q312B $235	M312C $245	E312C $390	F313A $775	G313A $775	E/H
						F314A $950	G314A $950	**PRECISION PHASE SHIFTERS**
								DIRECT READING FREQUENCY METERS Precision
Y410A $210	K410A $230	U410A $250						Reaction
			Q410X $325	M410X $300	E410X $500	F412A $750	G412A $750 G413A $800	Reaction, micrometer
								Transmission
Y501A $ 24	K501A $ 30	U501A $ 35	Q501A $ 95	M501A $ 90	E501A $150	F501A $150	G501A $150	**TERMINATIONS** Fixed
Y502A $ 50	K502A $ 70	U502A $ 75						Sliding
								High power
Y510A $450	K510A $480	U510A $625						**STANDARD MISMATCHES** VSWR 1.00
Y510B $325	K510B $340	U510B $525						VSWR 1.05
Y510C $275	K510C $280	U510C $450						VSWR 1.10
Y510D $225	K510D $240	U510D $280						VSWR 1.20
Y510E $325	K510E $340	U510E $350						VSWR 1.50
								WAVEGUIDE-TO-COAX ADAPTERS
Y610A-D $100 Models A-3DB, B-6DB, C-10DB, D-20DB	K610A-D $165	U610A-D $185		M610A-D $500				**DIRECTIONAL COUPLERS** Multihole
Y612D $ 55	K612D $110				Models D-20DB, E-25DB			Crossguide
Y620A $ 40	K620A $ 45	U620A $ 55	Q620A $ 65	M620A $ 60	E620A $110	F620A $275	G620A $275	**WAVEGUIDE TEES** Series
Y621A $ 40	K621A $ 45	U621A $ 55	Q621A $ 65	M621A $ 60	E621A $110	F621A $275	G621A $275	Shunt
Y622A $ 54	K622A $ 65	U622A $ 80	Q622A $100	M622A $100	E622A $170	F622A $325	G622A $325	Hybrid
Y623B $ 32 Y624B $ 32	K623B $ 38 K624B $ 38	U623B $ 42 U624B $ 42	Q623B $ 55 Q624B $ 55	M623B $ 50 M624B $ 50	E623B $ 90 E624B $ 90	F623A $275 F624A $275	G623A $275 G624A $275	**WAVEGUIDE BENDS** 90° E-plane 90° H-plane
Y625A $ 60	K625A $ 60	U625A $ 70	Q625A $100	M625A $100	E625A $100	F625A $100	G625A $100	**WAVEGUIDE 90° TWISTS**
Y630C $145	K630C $155	U630B $150	Q630B $155	M630C $160	E630B $250	F631A $275	G631A $275	**PRECISION SLIDING SHORTS**
Y634A $ 35	K634A $ 38	U634A $ 38	Q634A $ 50	M634A $ 50	E634A $ 50	F634A $ 85	G634A $ 85	**STRAIGHT WAVEGUIDE SECTIONS (Min. length)**
Y638A $125	K638A $150	U638A $175	Q638A $120	M638A $125	E638A $250	F638A $200	G638A $200	**STANDARD GAIN HORNS**
Y641A $250 Y641AE $275	K641A $275 K641AE $300	U641A $300 U641AE $325						**WAVEGUIDE SWITCHES**
								SHIELDED TUBE MOUNTS
			Q780A $165	M780A $160	E780A $250	F781A $475	G781A $475	**HARMONIC GENERATORS**
Z910B $ 7	Z910B $ 7	Z910B $ 7	Z910C $ 7	Z910C $ 7	Z910C $ 7			**WAVEGUIDE STANDS**

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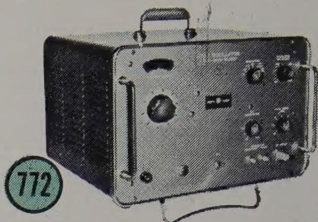


SIGNAL SOURCES

- 950 to 2000 MC. Model L772A $1340
- 1900 to 4000 MC. Model S772A $1340
- 3950 to 8200 MC. Model C772A $1340
- 7000 to 11000 MC. Model X772A $1340

TEMPERATURE COMPENSATED POWER METER

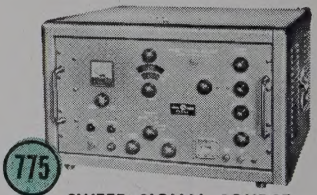
- Power Range, full scale −20DBM or 0.010 MW. to + 5DBM or 3.00 MW.
- Type 218 Heads required

Model B831A • $335
Model B832T (Transistorized) • $450

UNIVERSAL KLYSTRON POWER SUPPLY

- Beam: 200-3600V
  Grid: 0 to +150V; 0 to −300V
  Reflector: 0-1000V

Model Z815B • $1350



SWEEP SIGNAL SOURCE

- Freq. Range: 8200-12400 MC.
- Provisions for AGC

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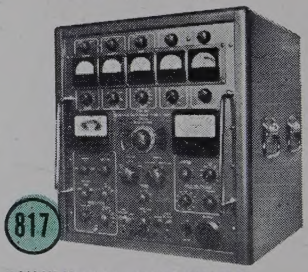


UNIVERSAL MICROWAVE POWER SUPPLY

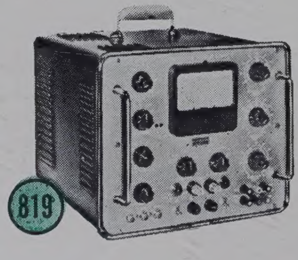
- Helix: 0-3500V
- Filament: 0-15V D.C.
- Separate Grid Voltages #1, #2, #3, #4 plus Collector and Anode Voltages

Model Z817A • $2650

STANDING WAVE AMPLIFIER

- Full scale sensitivity, 0.1μV signal-to-noise ratio 3:1
- Tunable 1000 cps filter

Model B812A • $225



KLYSTRON POWER SUPPLY

- Beam: 300-1000V at 85 MA.
- Grid: 0 to +150V; 0 to −300V
- Reflector: 0-900V

Model Z819A • $625

Detecting The Invisible Half of Matter

An overwhelming percentage of space is a relative void, but drifting in that void are vast seas of rarified material, known as the interstellar medium. The amount of material in the interstellar medium is comparable with the total mass of the stars and is composed primarily of gas and dust. Giant radio telescopes, combined with the most sensitive radio devices ever constructed, are probing the interstellar medium. In this manner, radio astronomers seek answers for some of the most provocative questions posed by science.

Because interstellar space is so very cold, the major portions of the interstellar medium are optically invisible. For the most part, the presence of the medium can be detected only by radio astronomical techniques which are capable of measuring the minute amount of radio energy generated in space. Spectral line radiation from the interstellar medium is the most profitable area of study.

The gas which has been the main research objective is atomic hydrogen. A hyperfine transition in the ground state of the hydrogen atom occurs at a frequency of 1420.40572 ±0.00001 Mc. Around the Milky Way, the hydrogen line appears in emission. In the direction of discrete sources (radio stars) the line is reversed and appears in absorption. Signal powers produced by this radiation at the terminals of an antenna are usually of the order of 10^{-18} watts; therefore, extremely high receiver sensitivities are required for research programs.

The study of this radiation is being vigorously pursued at the major astronomical observatories of the world. Objectives of the research programs include a measurement of the mass of the Milky Way, measuring the distance from the earth to the sun, determining distances to radio stars, mapping the spiral arms of the Milky Way, measuring the interstellar magnetic field, and measuring the gas content of island universes at very remote cosmic distances. A precise determination of a hydrogen line profile is critical for all these research programs. To accomplish this determination, a radiometric system must be extremely stable, ultra-sensitive, retain "flat" critical RF parameters while scanning, and operate reliably and dependably.

The development and manufacture of receiving systems meeting requirements such as those described above has been Ewen Knight's major activity for a decade. Ewen Knight radiometric systems are in daily operation at the leading radio astronomy laboratories in the Americas. Other systems, destined for giant radio telescopes now under construction in the United States, are now taking form at Ewen Knight. Similar receivers are being developed for missile trackers and radiometric navigation systems. Our staff, accustomed to "frontier" demands, stands ready to translate your most complex solid state or conventional microwave system requirements into reliable instrumentation.

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Signal Processing Antennas

A Simple Method of Transforming Impedances Through a Lossless Network

Arcing in CW Transmitters

Determination of Maximum Insertion Loss Error Due to Mismatch

Concerning Hybrids

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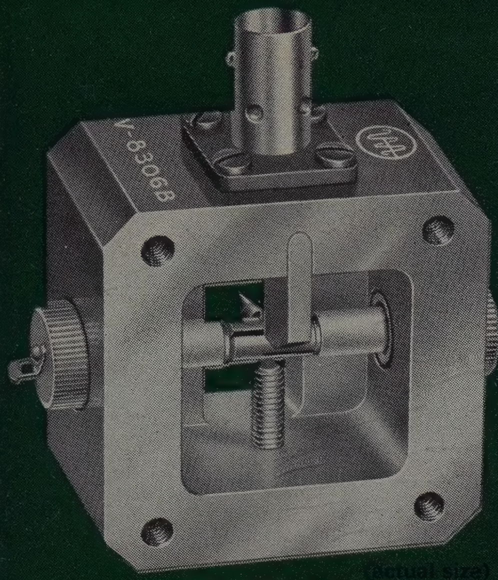
BPA



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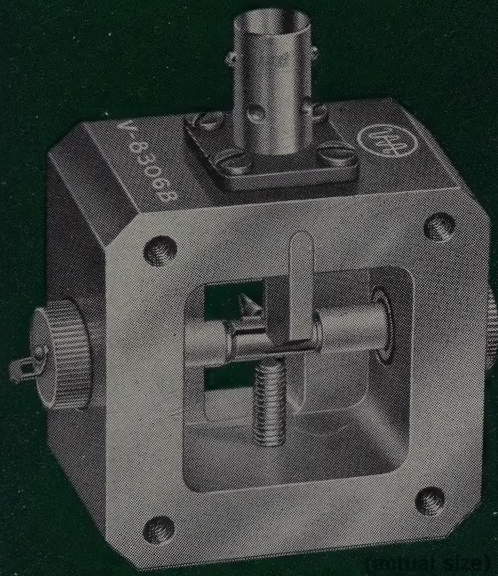
MIXER



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MODULATOR

V-8306B
Carrier Frequency, 7.6-8.6 kMc
Carrier Power, 300 mW max.
Modulating Signal Frequency, 0-100 Mc/s
Carrier Rejection, 20 db minimum
Conversion Efficiency, 8 db nominal

THE MIXER WITH THE DUAL PERSONALITY

Here's important design news! Varian Orthomode® balanced mixers are equally effective as modulators.

When any of Varian's broad line of mixers is operated as a modulator—with microwave power applied to a waveguide port and modulating signal voltage to the IF connector—conversion loss approaches the minimum theoretical level.

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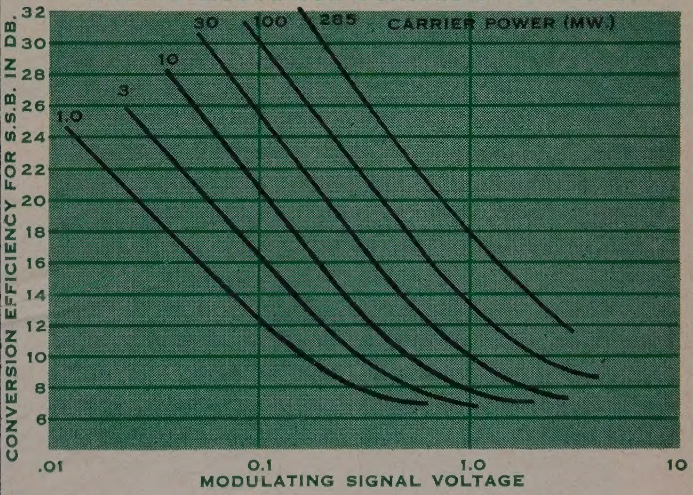
V-8306B MODULATOR CONVERSION EFFICIENCY



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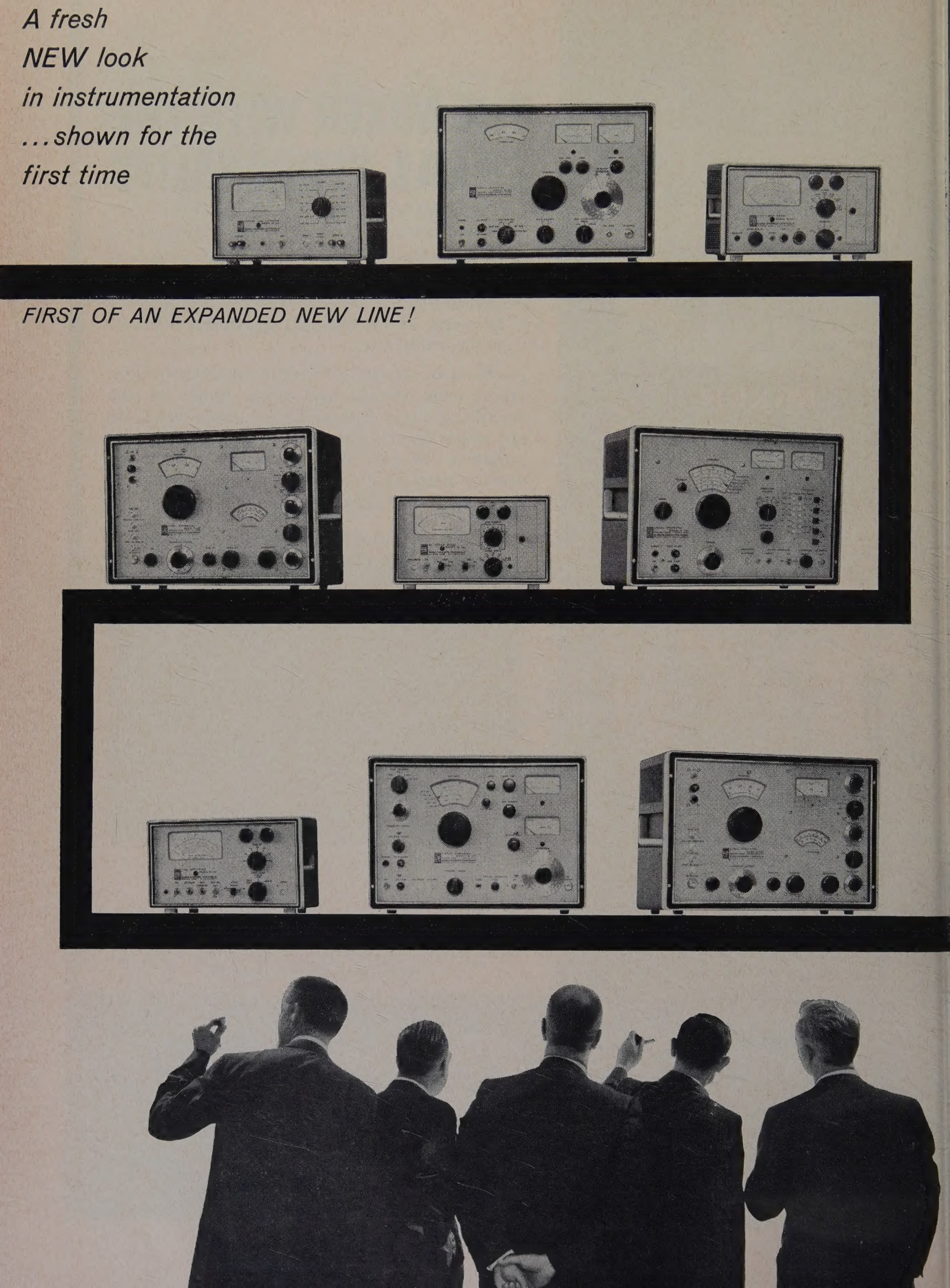
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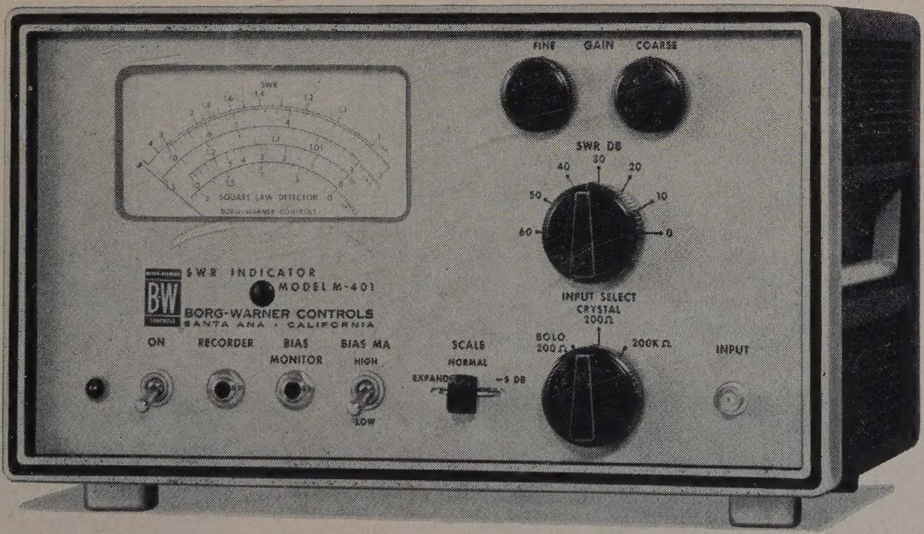
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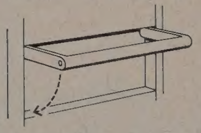
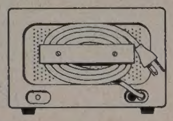


WIND-UP POWER CORD



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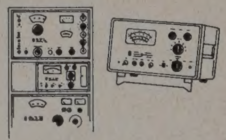

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MICROVIEWS
OF THE MONTH

77 ▶ AN ACCURATE ATTENUATION MEASURING SYSTEM WITH GREAT DYNAMIC RANGE

B. O. Weinschel

The major methods of making attenuation or insertion loss measurements are described and their major error sources and range limitations are discussed. The precise definition of insertion loss is clarified, and the important factors in selecting a measurement method are listed. The operation and basic principles of the Weinschel parallel i.f. substitution test set are described. This instrument covers an attenuation range of 106 db with an accuracy of a few tenths of a db. Over the central 60 db range its accuracy approaches .01 db. It covers the frequency range from 100 to 12,400 Mc. Sources of error common to all measurement methods are discussed, and basic data is presented on the errors due to signal leakage, system noise and impedance mismatch.

84 ▶ MICROWAVE TWO-PHASE CONVERTERS FOR IMAGELESS RECEIVERS

R. B. Wilds

A practical method of achieving image suppression over octave RF bandwidths in voltage-tuned receivers, where rapid sweep rates render mechanical filtering impractical, is described. This method uses special RF two-phase converters in conjunction with special IF circuitry to provide image suppression by phase cancellation.

88 ▶ THE "CROSS-OVER" DIRECTIONAL COUPLER

Victor J. Albanese and Herman Kagan

A new directional coupler, which incorporates the features of the quarter-wave branch coupler with those of the 3 db cross-over hybrid, is described. The device is treated theoretically, and is shown to have flat electrical characteristics over wide bandwidths. An experimental model is shown, and practical design problems are discussed.

92 ▶ RECENT ADVANCES IN LOW-NOISE TRAVELING-WAVE TUBES — Part II

C. Louis Cuccia and Herbert J. Wolkstein

Part I of this paper, published last month, discussed the design techniques involved in achieving low noise output in traveling-wave tubes. This second and concluding part describes various types of tubes designed to provide specific noise-figure ranges at S- and L-band frequencies. The types discussed include developmental ultra-low-noise tubes having noise figures below 4.5 db, solenoid types having noise figures from 5 to 8 db, wide-band types having noise figures from 7 to 11 db, and periodic-permanent-magnet-focused types having noise figures from 10 to 16 db.

99 ▶ LONG LINE EFFECT IN PULSE COMPRESSION RADAR

John Reed

For pulse-compression radars phase non-linearities introduced by the system must be limited for satisfactory operation. Relations between standing wave ratios existing in a transmission line and the resulting phase non-linearities are presented in graphical form, useful for predicting design specifications.

OUR COVER

Shown is the RCA-6861 low-noise traveling-wave-tube amplifier and some of its component parts. Typical characteristics of the 6861 include a noise figure of 6.5 db and a gain of 25 db at 3100 Mc. The 6861 covers the range of 2700 to 3500 Mc. In use for over five years, the 6861 is the forerunner of today's ultra low-noise traveling-wave tubes such as the RCA Developmental Type A-1207. Samples of this developmental type have shown terminal noise figures substantially below 4 db — brought about by the use of an improved electron gun. Both types are in the 1 milliwatt power output class and are intended for use in the input and IF stages of radar, scatter-propagation, and other types of microwave receivers. See page 92.

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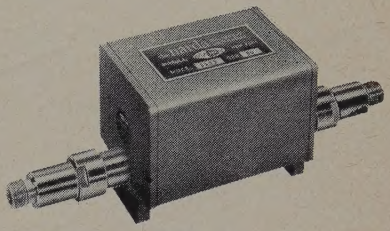
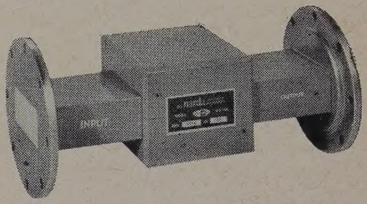
errite isolators

Excellent electrical characteristics with extreme versatility! 7/8" coaxial line construction allows higher power operation with 7/8" connectors, up to 20 kw peak, 400 watts average. (Normally supplied with Type N, 3/8" connectors; 10 kw peak, 10 watts average.) Features 15 db isolation and 1 db max. insertion loss. VSWR is 1.25 max. based on 2:1 load mismatch; 1.15 max. into matched load. Model 1233: 2.0–4.0 kmc; model 1233-1: 3.0–5.5 kmc; $450. each.



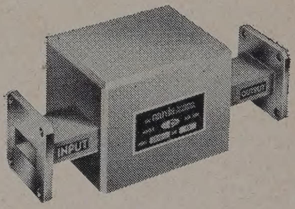
• low power broadband waveguide
errite isolators

Provide maximum load isolation and minimum insertion loss over full standard waveguide frequency ranges. Extremely useful for maintaining signal source stability and eliminating long line and frequency pulling effects. Front-to-back ratios are the highest available on the market today: C Band—26:1, $250; XN Band—25:1, $225; XB Band—30:1, $235; X Band—30:1, $220.



• high power broadband waveguide
errite isolators

The only line of high power isolators that covers all of X Band with just two models (8.2-10.0 kmc and 10.0-12.4 kmc), each with front/back ratio of 40:1. Input power rating: 250 kw peak, 300 watts average, achieved through use of special high Curie temperature ferrite materials. VSWR is 1.05 max. with matched load; 1.10 max. with 3:1 mismatch. Only $175 each. Model with same VSWR, 28:1 front/back ratio, 300 kw peak, and 300 watts average, for 7.05-10.0 kmc, $195.



• other ferrite devices—
onsult NARDA for:

• Circulators • Phase shifters • Modulators • Attenuators • Special Isolators

For more information, write to Dept. MJ-1.

the narda microwave corporation

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Circle Reader Service Card 4

TO ACHIEVE THIS GOAL . . .

One of the basic principles on which this magazine was established was the intent on our part to save you time. Our philosophy was to furnish you with good technical information carefully selected and reviewed. It was our belief that in that way we could minimize your searching for good technical papers in the field of microwaves.

To achieve this admittedly ambitious goal, we were careful to select our editorial staff from experts in the industry itself. As the magazine has attracted more and more interest from people in the industry, we have experienced a steady increase in the amount of unsolicited good material submitted for possible publication.

To cope with this situation, we have periodically added reviewers to our editorial staff. They are all well known experts in at least one area of microwaves.

In addition to solving our editorial problems, we have also given much attention to administrative problems relating to the publication of the magazine.

Our goal has always been to provide information both technical and non-technical that bears the stamp of authenticity. To achieve this goal, we selected our editorial staff from within the industry. We have chosen to augment our operating staff in similar fashion.

The most important new addition is a full time editor in the person of Eugene Hadge. Gene received his BA and MA in Physics from Boston University. He has spent 14 years as a working microwave engineer and engineering manager at Microwave Development Laboratories, Gabriel, Sage and most recently Raytheon. He will be a full time editor and will take over most of my present functions, in addition to other responsibilities.

In addition, we have also added Tom Hurley, most recently of CBS Electronics, to head up our promotion department and Dale Anderson to direct our circulation department.

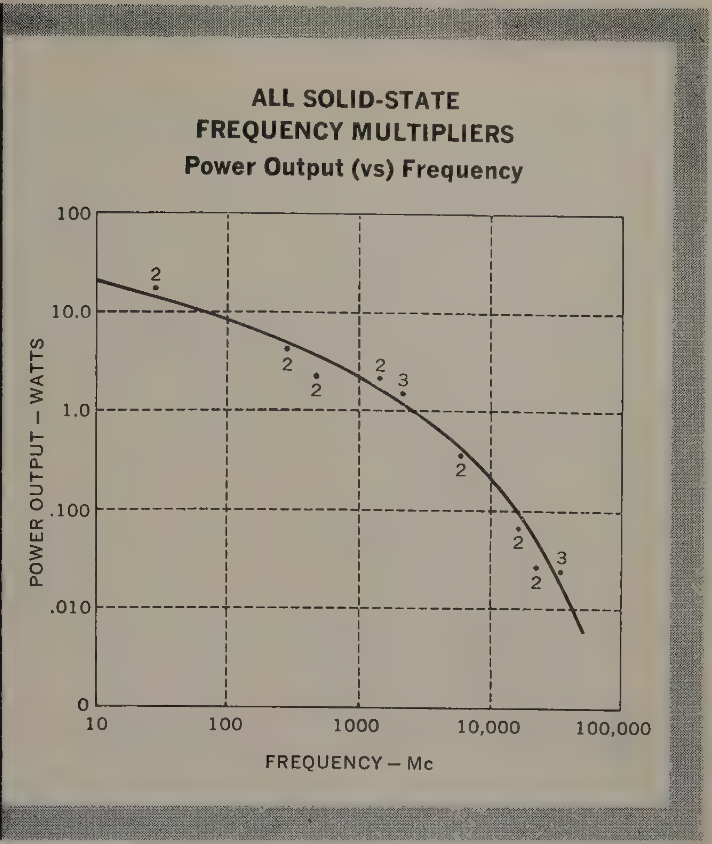
In the future we hope to add other qualified people to help serve you with enthusiasm and interest.

For our latest list of editorial associates and operating staff, let me call your attention to our new masthead on page 2.

Ted Saad

MICROWAVE ASSOCIATES PROGRESS REPORT

Microwave Power from Varactor Diodes


ALL SOLID-STATE FREQUENCY MULTIPLIERS
Power Output (vs) Frequency

fficient conversion of microwave power has been omplished with a variety of new varactor fre- ncy multipliers developed at the Waveguide tems Division of Microwave Associates, Inc.

Ve have produced microwave power of several tts at UHF frequencies, several hundred milliwatts X-band frequencies, and tens of milliwatts at Ka- d frequencies. The curve above indicates more urately the power levels achieved by these Micro- ve Associates units. They employed doublers and lers.

Efficiencies of these units range from 80 — 90% in UHF region and from 20 — 30% at X-band. At sent, the highest efficiencies are achieved at rela- ely narrow bandwidths (1%-2%). However, our abilities are rapidly improving efficiencies for ader band operation. An example of a fixed-tuned adband unit is a "tripler" which provides an out- t of 10 milliwatts over a 14% range at X-band.

Because of their efficiency and simplicity, these fre- ency multipliers are of considerable interest to sys- ns engineers designing radar exciter circuits, low- wer transmitters, stable local oscillator and paramp mp sources, and other circuits which require high quency stability and exceptionally long life. These ractor multiplier circuits are generally passive, re- iring neither tuning nor external bias voltage.

Our progress in producing efficient microwave power with all-solid-state techniques is related to performance of the most advanced high-power epitaxial varactors with significantly lower losses. The capabilities of Microwave Associates' Semiconductor Division in producing such varactors is a most positive asset. As this article is being printed, the multiplier performances shown here have already been exceeded.

We are also developing chains of these frequency multipliers to provide moderate amounts of power when driven by transistor oscillators. Efficiencies of these multiplier chains (RF output/DC input) are as good or better than equivalent klystron sources. Compactness and all-solid-state reliability are equally important benefits.

If you have an application for efficient varactor frequency multiplication or would like to discuss the very latest capabilities of these units, please write to Mr. Herbert Cox, Waveguide Systems Division. We'll be pleased to send you a new article on Varactor Frequency Multiplication by Mr. M. E. Hines.

MICROWAVE ASSOCIATES, INC.
WAVEGUIDE SYSTEMS DIVISION
Burlington, Massachusetts • BRowning 2-3000
Western Union Fax • TWX: Burlington, Mass. 942

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36 W. 44th Street, N.Y.C., N.Y., U.S.A., Cable MICROKEN

POLARAD

ONLY POLARAD CAN A 4,000 mc BANDWIDTH VISUAL MICROWAV

Polarad takes another gia stride in advancing t state of the art for mic wave research and develo ment—you can now obser a complete *4,000 mc* ban width on *one scope, at o time,* with the new Mod WSA Wide Band Spectru Analyzer.

Here's the value to microwa engineers. To see the *enti* tuning range of transm ters, generators and other broadband device just push one appropria band selection button— *tracking,* no further tunin

Here's the value in RFI wo Because you can view wide band of frequencies one time, you can see inte fering signals instantl And by switching over narrow band analysis, th exact nature of the sign can be determined—an a in compiling a "spectru signature."

Model WSA joins the mo comprehensive line of visu microwave analysis equi ment available today.

SPECIFICATIONS MODEL WS

Frequency Range
10 mc to 40,000 mc in 20 Banc

Band Selection
Automatic; with illuminate pushbuttons

Dispersion
Narrow Band: 1 mc to 25 mc.
Wide Band: 50 mc to 4,000 m

Resolution..............Narrow Band: 20 k
Wide Band: 1.5 m

I-F Frequencies
8,200 mc, 3,600 mc, 1,000 mc, 16 mc, depending on band selection.

High Intermediate Frequency
Assures image rejection an prevents video detection.

SPLAY
R
NALYSIS

hich of these
larad Microwave
ectrum Analyzers
ves your problem?

m 10 to 100,000 mc, Polarad offers
trum analyzers for every aspect
microwave research and develop-
t. Thousands of the instruments
vn here are in use today through-
the electronics industry—in la-
tories, on the production line, in
ems, out in the field and at re-
ch centers.

your Polarad representative to
k with you in selecting the equip-
t that will most efficiently accom-
n your objectives.

OLARAD SPECTRUM ANALYZERS FEATURE:

o 30 cps adjustable sweep rate

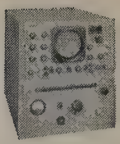
ect-reading UNIDIAL® tuning control, with
klystron modes to set

h accuracy, resolution and sensitivity

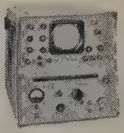
n-contacting klystron cavity chokes for
seless tuning

vision for use with Multi-pulse Spectrum
coder (Model SD-1)

UNIVERSAL OPERATION?

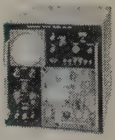


Self-Contained Units Cover
10 to 40,880 mc
MODEL SA-84
- **Dispersion: 10 to 55 mc:** 500 kc to 5 mc, adjustable
  55 to 40,880 mc: 500 kc to 25 mc, adjustable
- **Resolution:** 20 kc
- **Internal Marker:** variable



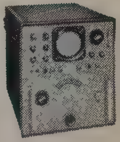
MODEL SA-84W
- **Wide Dispersion: 10 mc to 240 mc:** 10 mc
  240 mc to 40,880 mc: 80 mc
- **Resolution:** 2 kc to 80 kc variable
- **Crystal controlled markers from 10 to 40,880 mc**
- **Log-linear display**
- **Accurately calibrated IF attenuator**

TRANSISTORIZED MOBILITY?



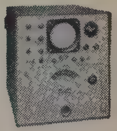
MODEL SA-84T
Single Unit Covers
10 to 40,880 mc
- **Dispersion:** 500 kc to 25 mc, adjustable
- **Resolution:** 20 kc at all frequencies
- **Internal Marker:** ± 13 mc
- **Power Consumption:** when battery operated, 110 watts, 12 vdc
- **Sensitivity:** —50 to —105 dbm, depending on frequency.
- **Weight:** 70 lbs. One half the weight of conventional vacuum-tube equivalent
  Meets MIL-1-26600 for r-f interference

STANDARD OPERATION?



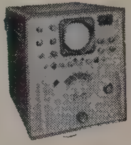
MODEL TSA
10 to 44,000 mc in 5 Plug-In Tuning Units
- **Dispersion:** 400 kc to 25 mc
- **Resolution:** 2 to 80 kc variable
- **Attenuation:** Continually variable
- **Sensitivity:** —50 to —95 dbm, depending on frequency
- **Internal Marker:** ± 14 mc

TIME AND FREQUENCY DISPLAY?



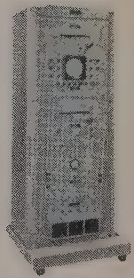
MODEL TSA-S
SYNCHROSCOPE ANALYZER
10 to 44,000 mc in 5 Plug-In Tuning Units
- **Bandwidth:** 5 kc, 50 kc, 500 kc, 5 mc
- **Synchroscope sweep rate:** 2, 10, 100, 1,000, 10,000, and 100,000 μ sec per screen diameter.
- **Dispersion, Sensitivity and Internal Marker** same as TSA.

WIDE DISPERSION?



MODEL TSA-W
Narrow And Wide Pulse Analysis
10 to 44,000 mc in 5 Plug-In Tuning Units
- **Dispersion:** 200 kc to 80 mc (2 ranges)
  80 mc dispersion displays pulses narrow as 0.1 μ sec. For wide pulses, dispersion may be adjusted down to 200 kc.
- **Resolution:** 2 to 80 kc variable
- **Internal Marker:** ± 40 mc
- **Screen Display:** Linear or log

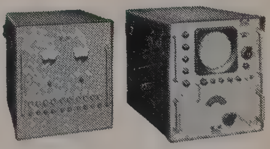
ULTRA-BROAD BAND?



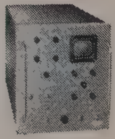
MODEL WSA
Self-Contained Unit Covers
10 to 40,000 mc in 20 Bands
- **Dispersion:** 1 mc to 25 mc in narrow band, 50 mc to 4000 mc in wide band
- **Resolution:** 20 kc in narrow band; 1.5 mc in wide band
- Rapid band selection by means of illuminated push-button switches.
- Frequency difference marker up to 4000 mc.
- **Sensitivity:** —50 to —80 dbm, depending on frequency

EXTENDED FREQUENCY?

MODEL DA-70
50,000 mc to 100,000 mc
in Three Bands
- **Dispersion:** Continuously adjustable from 50 mc to 1000 mc. Permits narrow pulse inspection.
- **Resolution:** 1 mc
- High intermediate frequency assures image rejection and prevents video detection.
- **Dial Frequency Accuracy:** ±1.0%
- **Nominal Sensitivity:** —50 dbm for entire frequency range.



SPECTRUM SELECTOR?



MODEL SD-1
MULTI-PULSE SPECTRUM SELECTOR
Permits spectrum analysis of individual microwave pulses in a pulse group when used with any Polarad Spectrum Analyzer. Any pulse in a complex coded signal may be isolated for examination.

OLARAD **FREE LIFETIME SERVICE**

LECTRONICS CORPORATION

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Industry News

KAISER NAMED MARKETING MANAGER AT STEWART

Stewart Engineering Co., Santa Cruz, Cal., manufacturer of microwaves tubes and related equipment, has augmented its management staff by appointments in both the marketing and engineering departments.

Assigned to the newly-created post of manager of marketing is Bruno Kaiser, formerly employed by Varian Associates, Goodyear Aircraft, and the Martin Company. Kaiser holds an electrical engineering degree from Ohio State University and a masters degree in business administration from Stanford.

Assigned responsibility as advanced development engineer is Albert T. Isaacs, who has held previous assignments with DuPont of Canada and with the Naval Research Labs of Canada. An Honors graduate of Nova Scotia Technical College, Isaacs holds a masters degree in Applied Science from the University of British Columbia, and has performed advanced microwave studies at Stanford University

—mwj—

RCA PROMOTES THREE IN MICROWAVE TUBE OPERATIONS

Three promotions in Microwave Tube Operations of the RCA Electron Tube Division, Harrison, N. J., have been announced by H. K. Jenny, Manager, Microwave Engineering.

The new appointments are Markus Nowogrodzki, Manager, Product and Equipment Engineering; Herbert J. Wolkstein, Manager, Microwave Design and Development; and Edward J. Homer, Manager, Microwave Engineering Administration and Data Systems Development.

Mr. Nowogrodzki also will direct the work of the applications and test group and the equipment and tube development laboratories. He will be responsible for the execution and control of all product and equipment development programs.

As Manager of Design and Development, Mr. Wolkstein will supervise the activities of a large number of design engineers and engineering leaders in developing new microwave products and improving existing ones. He will also prepare and recommend proposals for the development of new products.

Mr. Homer will be responsible for the administration of microwave engineering activities and for the development and coordination of data-flow systems for the management and control of microwave-tube manufacturing systems.

—mwj—

DR. SOLT NAMED MICROWAVE PHYSICS HEAD AT FAIRCHILD

Dr. Irvin H. Solt, Jr. has been named to head the new Microwave Physics Section of the Research and Development Laboratory of Fairchild Semiconductor Corp., Mountain View, Cal.

Dr. Solt, who was an experimental physicist with the Hughes Aircraft Company's Research Laboratories at Malibu, California prior to joining Fairchild, will investigate the applications of semiconductor technology to microwave components, according to Dr. Gordon E. Moore, head of Research and Development at Fairchild.

At Hughes Dr. Solt was associate section head of the solid state physics section and did experimental work in magnetism. This work consisted primarily of magnetic resonance investigations of numerous ferrites to rare earth iron garnets.

A native of Pennsylvania, Dr. Solt received his bachelor of science degree from Yale University in 1950 and was awarded a PhD in Physics from Massachusetts Institute of Technology in 1955.

Dr. Solt is a member of the American Physical Society, the Audio Engineering Society and Sigma Xi.

—mwj—

(*Continued on page 15*)

MEC *Reports*

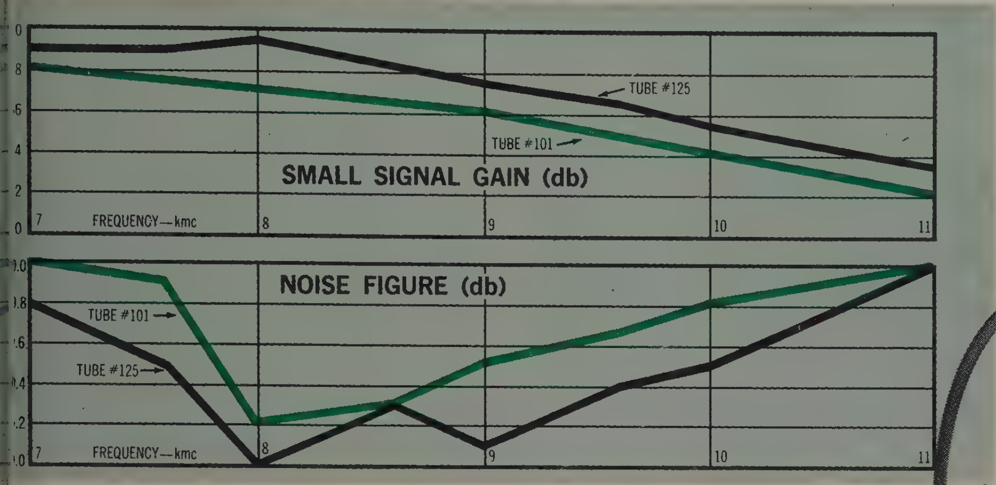
S, C and X-Band,
Metal-Ceramic, PPM Focused,
Magnetically Shielded,
10 mw Output and 30 db Gain
with Maximum Broadband
Noise Figure of 10 db.

Typical of MEC's advanced family of metal ceramic low noise traveling-wave tubes is the new M2105. Rugged and reliable, this tube is the result of engineering skill and manufacturing care appropriately combined to form a production tube with truly reproducible characteristics.

Shielding of the tube and its focusing structure, an advantage of the PPM format, eliminates the effect of stray magnetic fields and permits use of tubes in close proximity to magnetic materials or to each other. Elimination of the focusing solenoid and power supply reduces power consumption to less than 3 watts, including heaters, and does away with auxiliary cooling.

Ask for your copy of our new catal

ow Noise TWT's with PPM Focusing



REPEATABILITY MEANS RELIABILITY. Notice how closely the small signal gain and noise figure characteristics for the first M2105 (#101) compare with those of the last member in the first lot (#125).

ity—
in Feature of MEC Tubes

-ceramic construction gives
tubes a headstart on reliability.
ire evacuated at higher temper-
(650°C), producing a higher
n and cleaner environment for
athode life.

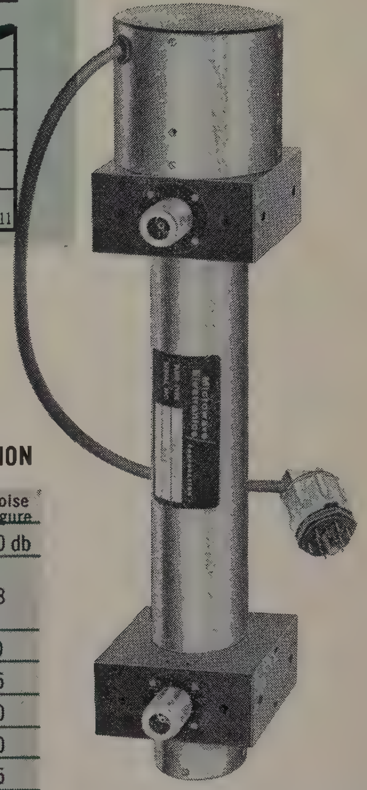
ntly rugged, they provide supe-
rformance over environmental
hes. (The M2105 withstands
ock and 15 g vibration between
2000 cycles with no degradation
ormance. Temperature compen-
work is now being completed.)

construction features also in-
a stacked ceramic gun and a
rigidly supported by three
c rods. Critical turn spacing is
tely maintained to assure uni-
gain characteristics from tube-
. The tube can be operated in
sition without change in char-
tics.

MEC's new short form catalog with complete information on our production engineered line of traveling-wave tubes is available now. In addition to low noise types, the catalog covers medium and low power, serrodyne, and special purpose tubes. For your free copy, call your nearest MEC engineering representative or write to us.

TYPICAL LOW NOISE TWT TUBES IN PRODUCTION

PPM FOCUSED TUBES	Frequency Range	Small Signal Gain	Saturation Power	Noise Figure
M2103 Series (Family)	2 - 4 kmc	30 db	10 mw	10 db
	(over 0.5 kmc portion of the band)	30	10	8
	2.3 - 4.4	30	10	10
	2 - 4	30	10	15
M2112 Series	4 - 8	30	10	10
	4.3 - 7.4	30	10	10
	4 - 8	30	10	15
M2105 Series	7 - 11	30	10	10
	7 - 11	30	10	15
	8 - 12.4	30	10	15
M2114	12.4 - 18	30	5	14
SOLENOID FOCUSED TUBES				
M2103 Series	2.0 - 4.0 kmc	30 db	5 mw	8 db
	(over 0.5 kmc portion of the band)	30	5	6
M2107	4.0 - 8.0	30	5	10
M2101 Series	7.0 - 11.0	30	10	9
M2114	12.4 - 18.0	30	5	12



Model M2105 Low Noise TWT weighs 5 pounds and is 12⅝" long.

MEC

MICROWAVE
ELECTRONICS
CORPORATION
4061 Transport Street
Palo Alto, California
DAvenport 1-1770

Circle Reader Service Card 7

How would you choose between these two coaxial connectors?

The answer depends on your circuit requirements. The *ipc*® connector on the right was specially designed for a customer who needed a BNC-type connector for high voltage operation. We designed this connector for use up to 5000 vdc. It looks like the AMPHENOL® connector on the left, a standard BNC rated at the usual 500v.

This is typical of the differences between *ipc* and AMPHENOL connectors. Approximately 60 per cent of the *ipc* connectors we market each year are special designs to meet individual customer's requirements.

The AMPHENOL connector line, on the other hand, offers you the most complete selection of UG-types available from a single manufacturer as well as *Push-On*®, *Quick-Crimp*®, and *Subminax*® connectors.

So, you see, you really don't have to choose between the two. RF Products offers you industry's most complete line of standard coaxial connectors—AMPHENOL—as well as the custom engineered line—*ipc*. Together, they can solve all your connector problems.

You can get full details by writing for Catalog D3 which presents the AMPHENOL line in detail, and Catalog 11 which describes the *ipc* connector line. If you don't find the connector you want in these catalogs, call your nearest RF Products representative. He'll be happy to work with you to develop exactly the connector you need. *Registered Trademark*

RF PRODUCTS

ipc AMPHENOL

Division of Amphenol-Borg Electronics Corporation • 33 East Franklin St., Danbury, Conn.

Circle Reader Service Card 8

(*Continued from page 12*)

HUGHES APPOINTS DR. FIELD GROUP ASSISTANT HEAD

Dr. Lester M. Field has been named sistant group executive of Hughes Aircraft Company's components group, I. F. Richardson, vice president and group executive, has announced.

In his new position Dr. Field will assist in directing various phases of the group's operations and coordi-te further broadening of its expanding es of commercial products, Richardson id.

He will continue as director of the com-ny's microwave tube division, a post has held for the last 18 months, and a member of the company's technical ard.

Dr. Field previously served as associate rector of the research laboratories and director of the physics laboratory. He llaborated with Dr. J. R. Pierce in de-loping the first stable traveling wave be while with Bell Telephone Labora-ries.

— *mwj* —

IGH-SPEED IBM TELE-PROCESSING SYSTEM INTRODUCED

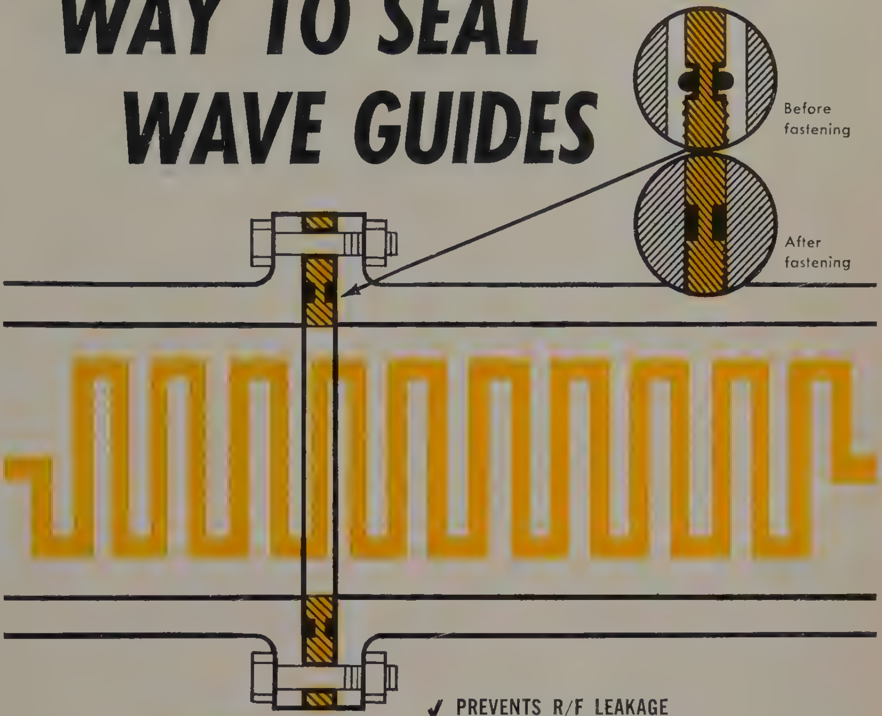
A high-speed IBM tele-processing sys-m linking computer centers in Manhat-n and Poughkeepsie, N. Y., has been troduced by IBM and the New York lephone Company. Representing IBM Warren C. Hume, president of IBM's ata Processing Division, and represent-g the New York Telephone Co. is alter A. Giles, vice president.

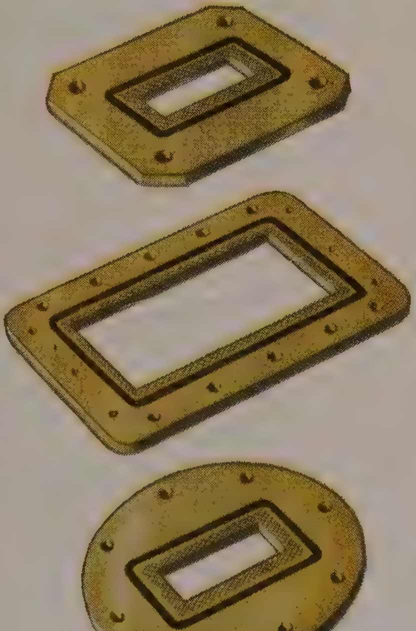
Data is sent between the two IBM mputer centers — in either direction or th ways at once — at a speed of 15,000 aracters per second. This is more than 000 times as fast as human speech.

The IBM tele-processing system is used

(*Continued on page 17*)

NOW THERE IS A BETTER WAY TO SEAL WAVE GUIDES





✓ **PREVENTS R/F LEAKAGE**
Metal-to-metal contact with "engraved fingers" on inside surfaces assures electrical continuity.

✓ **PROVIDES NO-LEAKAGE SEALING**
Controlled confinement of seal gland assures safe, sure, positive sealing — **exceeds** top hermetic specs!

✓ **ELMINATES ARCING AND/OR BURNING**
Designed to exacting requirements for proper mating of flanges as specified.

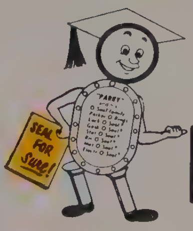
✓ **CAN BE RE-USED**
Seal is never "squeezed" beyond elastic limits, "memory" is constant, before, during and after fastening.

✓ **ECONOMICAL**
Eliminates cleaning or resurfacing flanges, no intricate machining required to accommodate the seal, and they're resuseable with just normal care.

✓ **STANDARDS FOR W/R SERIES**
Electr-O-Seals are available as standards to WR series Wave Guide flanges, assuring adequate supply and economy.

In addition to the standard WR series wave guide flange seals, Parker Seal Company also makes special seals to meet almost any specification or configuration. A nation wide group of field engineers are available to aid in expediting your requirements.

For more complete information send for catalog 5801.


SEAL FOR SURE!

Parker SEAL COMPANY
Culver City, California and Cleveland, Ohio
A DIVISION OF PARKER-HANNIFIN CORPORATION

Circle Reader Service Card 9

PERFORMANCE-PROVED
INTERCHANGEABLE
UNIFORM

PERFORMANCE-PROVED
INTERCHANGEABLE
UNIFORM

What's The Problem?

PARAMETRIC AMPLIFIERS

AND

VARACTOR DIODES

Tyco Semiconductor says there is no problem. Hidden costs of diode selection and elaborate tuning procedures are now being eliminated from parametric amplifier designs. Tyco Semiconductor's gallium arsenide varactor diodes are the answer. Strict electrical characteristics, **UNIFORM** operation, are the norm, not the exception—AP diodes are **INTERCHANGEABLE.** Tyco varactor diodes have been consistently **PERFORMANCE PROVED** by numerous field reports.

You benefit — not through interchangeability alone:
- new levels of low noise performance
- complete freedom to cool to −196°C
- reductions in pump power requirements
- accurate measurements at 10 kmc
- fco minimums specified at −2.0 volts
- controlled junction capacity spreads

simplified overall amplifier design

ELECTRICAL CHARACTERISTICS (measured at 25°C ambient temperature)

SYM.	PARAMETER	TEST CONDITIONS	AP-1	AP-2	AP-3	AP-4	AP-5	AP-6	AP-7	UNIT
BV_R	Reverse Breakdown	I_R=10 μa	6 min. for AP-1 thru AP-5					5 min.	4.5 min.	V
C_T	Total Capacitance	V=0, f=lmc	.5 to 1.5 for entire series							$\mu\mu$f
Q	Figure of Merit	V_R=2v, f=10kmc	6 min.	7 min.	9 min.	11 min.	13 min.	15 min.	19 min.	
fco	cut off freq.	V_R=2v	60 min.	70 min.	90 min.	110 min.	130 min.	150 min.	190 min.	kmc

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(*Continued from page 15*)

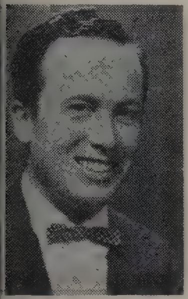
applied programming specialists working at both locations to help develop tomatic programming systems for IBM mputers. It utilizes specially-developed M 1945 magnetic tape transmission its, telephone cable, and a Bell System icrowave network.

At a press conference at the IBM Apied Programming Computer Center, me-Life Building, 1,000 listings from e Manhattan telephone directory were nt to Poughkeepsie, transmitted back d printed out. The actual transmission ne was just a few seconds.

—*mwj*—

DR. WILLENBROCK ACCEPTS SPERRY RESEARCH POST

Appointment of Dr. F. Karl Willenock of Harvard University as senior consultant of the Sperry Rand Research Center to be dedicated later this year in Sudbury, Mass., has been announced by Dr. James E. Shepherd, manager of the facility. Dr. Willenbrock also will act as research director during the mmer university recess and return to arvard in the fall.



Well-known in his present position as sociate dean of engineering and apied physics at Harvard University, Dr. Villenbrock will help to shape the adanced scientific programs now being rmulated for the Sperry Rand science nter.

Dr. Willenbrock received his masters egree in applied physics from Harvard 1947 and was awarded a PhD in elecon physics from the university three ears later. After serving on the instituon's faculty for 10 years, Dr. Willenrock was appointed to his present posion last year when he also was named irector of the laboratories, Division of ngineering and Applied Physics.

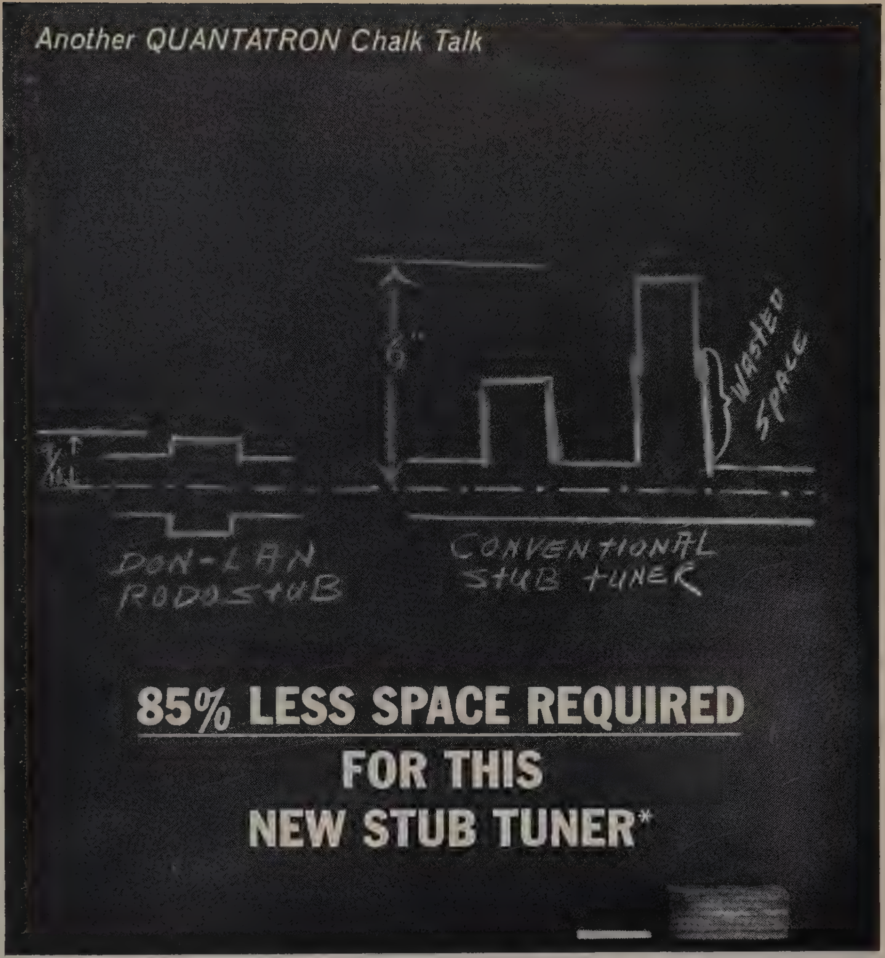
Immediately following his graduation rom Brown University with an electrical ngineering degree in 1942, Dr. Willenrock joined the Naval Ordnance Laboraory where he was engaged with undervater acoustics research. He later became Navy specialist in electronic equipment sed in anti-submarine warfare.

The scientist-educator is a consultant to he director of the Naval Research Group f the Office of Naval Research, as well s Sperry's Electronic Tube Division. His najor areas of interest are microwave hysics and solid state electronics.

Dr. Willenbrock is a member of the nstitute of Radio Engineers, the American hysical Society, the American Society for ngineering Education, Sigma Xi and Tau eta Pi.

—*mwj*—

(*Continued on page 42*)



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ACTUAL SIZE

*Patent No. 2,966,642

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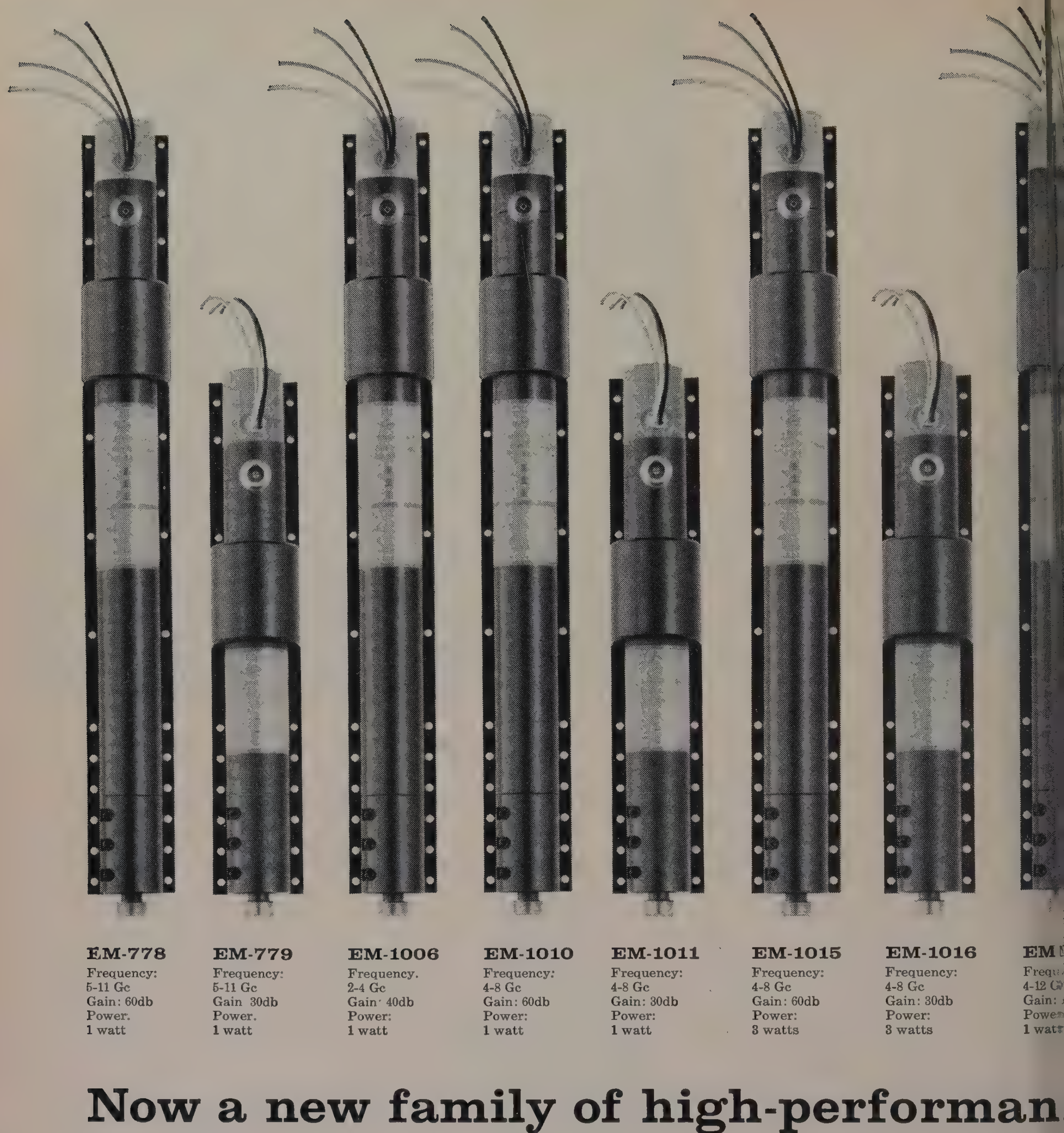

EM-778
Frequency:
5-11 Gc
Gain: 60db
Power.
1 watt

EM-779
Frequency:
5-11 Gc
Gain 30db
Power.
1 watt

EM-1006
Frequency.
2-4 Gc
Gain: 40db
Power:
1 watt

EM-1010
Frequency:
4-8 Gc
Gain: 60db
Power:
1 watt

EM-1011
Frequency:
4-8 Gc
Gain: 30db
Power:
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EM-1015
Frequency:
4-8 Gc
Gain: 60db
Power:
3 watts

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3 watts

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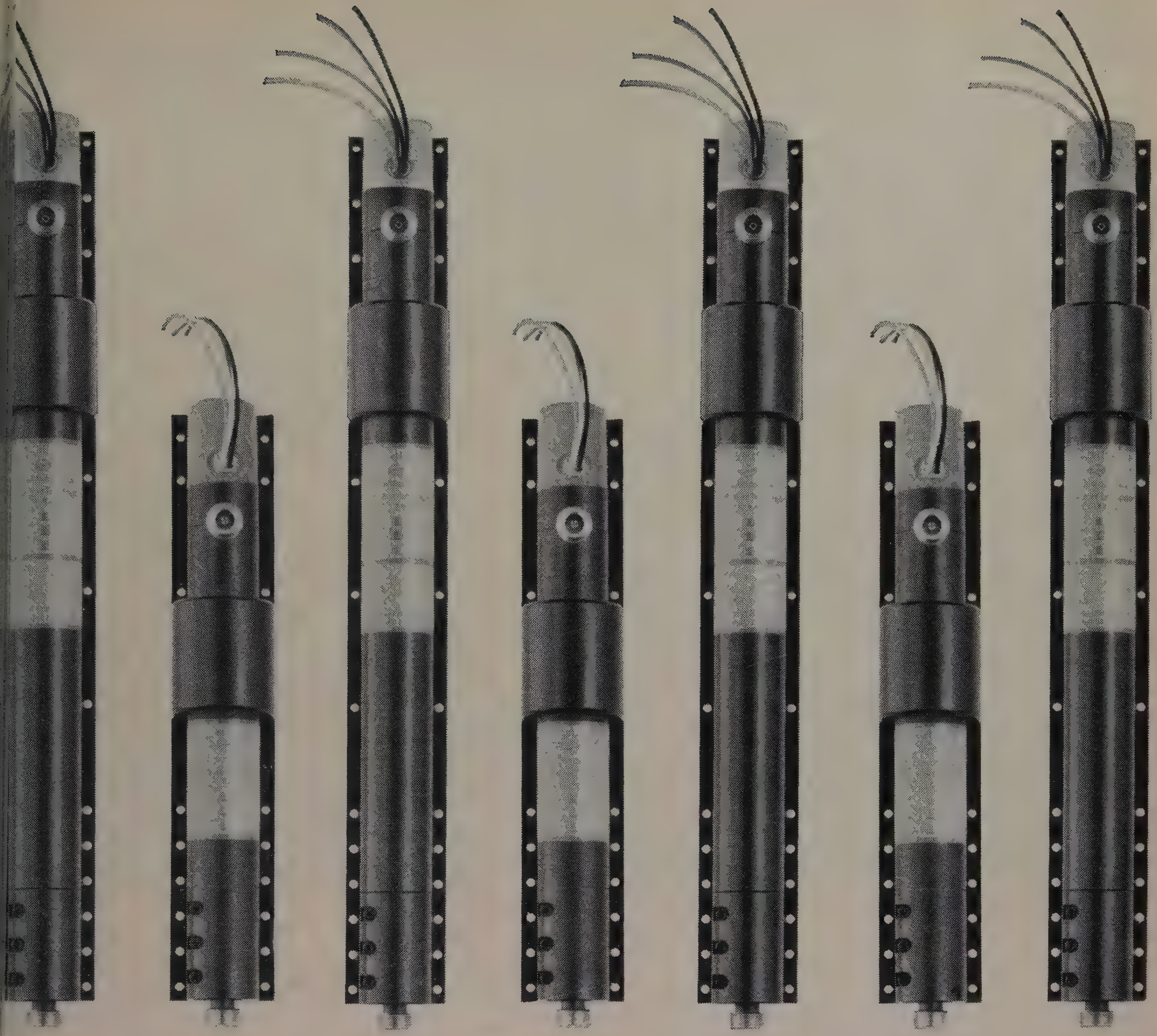

M-1030	EM-1031	EM-1045	EM-1046	EM-1050	EM-1051	EM-1060
requency:	Frequency:	Frequency:	Frequency:	Frequency:	Frequency:	Frequency:
11 Gc	7-11 Gc	8-12 Gc	8-12 Gc	8-12 Gc	8-12 Gc	2.5-11 Gc
ain: 60db	Gain: 30db	Gain: 60db	Gain: 30db	Gain: 60db	Gain: 30db	Gain: 30db
ower:	Power:	Power:	Power:	Power:	Power:	Power:
watts	5 watts	1 watt	1 watt	3 watts	3 watts	1 watt

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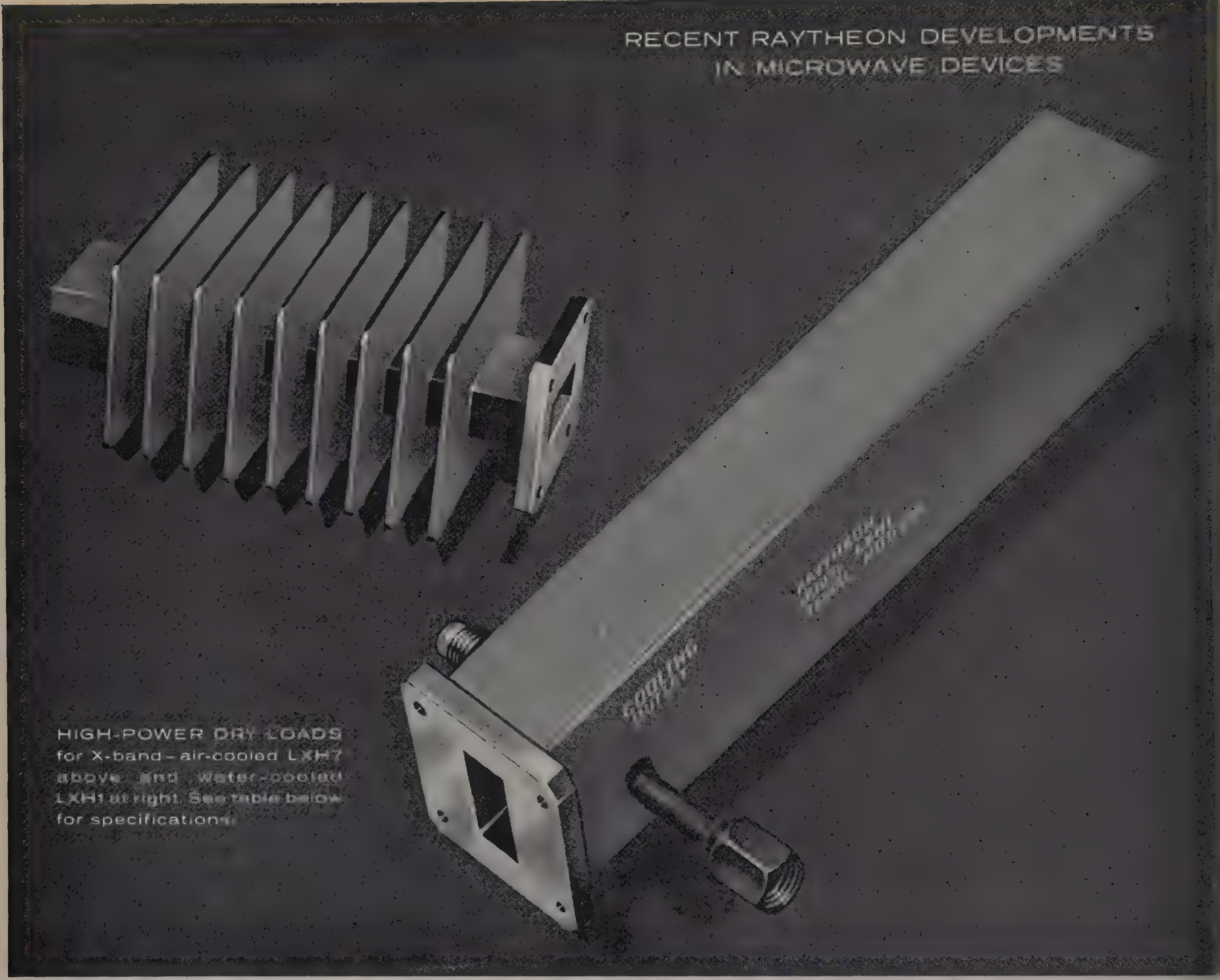

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TYPICAL SPECIFICATIONS — HIGH POWER LOADS

Band	UHF	S	S	X	X	X	X
Model No.	LUH1	LSH1	$\mathrm{L_{C}SH1}$	LXH1	LXH7	LXH11	LXH12
Freq. (kMc)	.325-.475	2.6-3.1	2.9-3.1	7.0-10.0	7.0-10.0	9.0-12.4	7.0-10.0
Av. Power	60 kW	25 kW	500 W	5 kW	600 W	5 kW	5 kW
Max. VSWR	1.10/1	1.10/1	1.10/1	1.10/1	1.10/1	1.10/1	1.10/1
Waveguide	WR 1800	RG75/U	RG96/U	RG51/U	RG51/U	RG52/U	RG51/U
Flange	Alum CPR-1800	UG584/U	UG45/U	UG51/U	UG51/U	UG39/U	UG51/U
Cooling	Liquid	Liquid	Liquid	Liquid	Air	Liquid	Liquid
Length	90	36	8 9/16	9	6⅛	9¾	7 15/16
Width	14	5 15/16	1″	1⅞	3⅛	1⅝	1⅞
Height	24½	5 5/16	2⅛	1 15/16	2½	1 11/16	1 3/16
Approx. Wt. (lbs.)	200	35	1.5	4.05	1	5	4

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"THE SCIENTIST CAN ADVISE, BUT ONLY THE PEOPLE CAN DO."

THIS SCIENTIFIC AGE?

. C. **PEASE** ASSOCIATE EDITOR, *the microwave journal*

One of the curious features of our culture is its capacity r speaking with glowing pride of the achievements of e scientific age even while it is exhibiting a profound norance of those achievements and of how they were complished. It is a curious ambivalence that suggests e existence of a schism that is both deep and possibly ngerous.

There are, it seems, two poles around which the in-llectual leadership of our culture is oriented. On the e side is the scientific and engineering domain of the servable and measurable fact; on the other is the do-ain of those who concern themselves with the aesthetics d interior awareness. That such a classification over-mplifies the situation is evident, but there does appear be a considerable degree of truth to it.

In considering the implications of this polarization, one ust first ask from whence it comes. Why should these lds of thought be separated? What force is there in e psychological dynamics of the culture that has re-lted in this divergence of attitude?

At the risk of [illegible] one can observe that the more [illegible] ce is on the non-scientific, [illegible] who deplore the "material- [illegible] scientific-engineering side, d who boast of their disinterest in such matters. Many these people go as far as to boast of their ignorance of ch matters. Quite evidently, they feel that they must emonstrate their abhorrence of the physical world. They parently feel that any knowledge of, or interest in, sci-tific matters would evidence a lack of zeal for their osen area of truth. There seems to be an almost religi-s repudiation of the value of objectivity.

By distinction, many scientists and engineers are ignor-t of aesthetic matters, but rarely are they proud of the ct. On the contrary, many of them seem eager to dis-lay what knowledge they have in such areas. Often, in ct, they overdo it and succeed only in making fools of emselves. But you do not hear them boasting of their ck of musical knowledge, or of their ignorance of art. hey may acknowledge such a deficiency, but they do so ith regret and perhaps shame, not with pride.

It is not the scientists that repudiate the artists, but vice versa. It is the aesthetic half that identifies the scientific and engineering community with the "affluent society" with its implication of overdependence on useless gadgetry and vulgar materialism. To the extent that the scientists respond at all to this charge, they seem to accept it, acknowledging collective shame for their part in providing the means for this degeneration of ethical value.

So it appears that it is largely the artistically minded group that has generated the schism — at least it is they who have taken the active step of rejection. The scientist-engineer has accepted this rejection sometimes with a shrug and sometimes with agreement. At the worst, the scientist has accepted with passivity the active judgment of the aesthetic-minded intellectual.

It is, however, a mistake to use this argument to shrug the problem off. It accomplishes nothing to say that the active fault is the other person's and that, therefore, nothing need be done.

First, we must ask if it is a fault. Since we of the scientific community often do seem to accept this judgment on our work, we have to ask if it is right. If we decide it is, then the next question is why we continue in this field. Why do we not all give up science and become barefoot poets?

Is it just that we have an irrational dislike of starvation? Or is it that we really do not agree, but simply cannot find a final argument against the judgment? Are we being forced into a yes-no answer when we truly feel that neither is correct?

One can argue that all truth is a unity, and that to impose a value judgment on its different parts is senseless. Which floor of a skyscraper is the most important, the top one that gives the widest view, or the bottom one on which the whole structure rests? — particularly if you have no "a priori" definition of which is top and which is bottom. The truths of science give a framework of objective facts within which the most subtle metaphysical argument must rest. It would be ridiculous to develop

(*Continued on page 22*)

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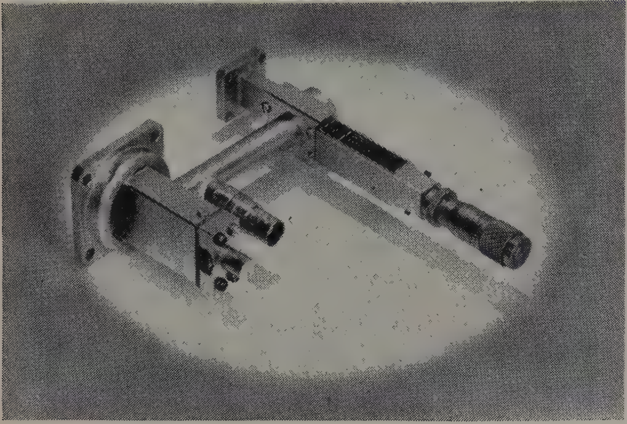

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Bandwidth	30 mc
Gain	15 db
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Pump Frequency	24.0 Gc
Diode	Texas Instruments Gallium Arsenide Diode
Pump Power	50 mw

For details on TI's X-band parametric amplifiers, write for Bulletin DLA-1231. For information on specific applications at all frequencies, contact RADAR AND MICROWAVE PRODUCTS DEPARTMENT.

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PEASE

(Continued from page 21)

an ontological philosophy which contradicts the observations of modern physics. And a philosophy of persona value which ignores the facts of modern psychology is of very little interest to anyone but its creator.

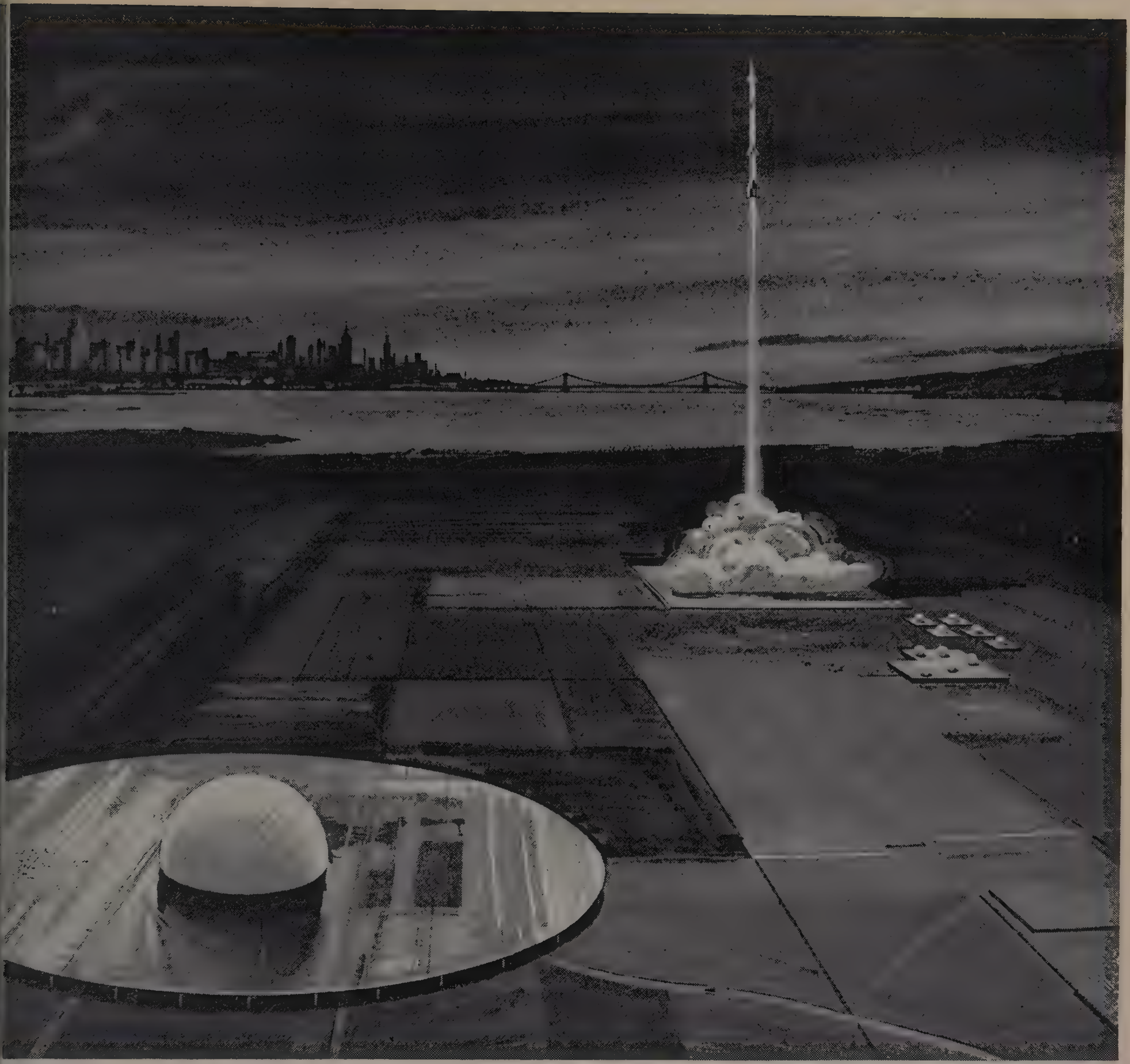
Nor does science stand alone. On the contrary, it is so dependent upon philosophy that it is difficult to define the boundary. Lord Bacon is often credited with being the father of "the scientific method." In this role, at least, he was functioning purely as a philosopher, and ever since his time the whole development of science has been shaped and directed by a succession of philosophers who have spent their lives attempting to define what constitutes scientific truth, purpose, and method. The shift from classical to modern physics was primarily a philosophic one. It was a shift in point of view which did not change the observed facts but which did completely shift our interpretation of them. Einstein, Heisenberg, Schrodinger, Dirac, and most of the other great names of this revolution are labelled as scientists, yet their greatest accomplishment was not in science itself but in the development of a new mode of thought for scientists to use.

Nor are the objectives of science defined by science itself. Broadly speaking, science can be defined as the collation and organization of observable facts of man. The definition, however, is too broad. No one can call himself a successful scientist who simply collects large volumes of facts. Darwin's reputation does not depend on the number of observations that he made, enormous as it was. Instead, he drew conclusions which were abstractions from the data. But even the conclusions were not entirely original with him. The concept of evolution, and even the principle of the survival of the fittest as one of the main forces of evolution, had been thought of before. What Darwin did was to compile an enormous volume of observable fact in support of these abstractions, thereby making them unignorable. It was the combination of data and organization that forced a revolution of thought.

And yet organization itself is not enough. Sir James George Frazer (The Golden Bough) also amassed a tremendous volume of data and organized it according to certain principles. In his time he had a great reputation as a scientist, and, in his way, had almost as large an impact on the public interest as Darwin. However, his reputation as a scientist has rather faded over the years. Darwin is still thought of as a great scientist, although the details of his conclusions have been much modified since his time. His impact on the development of that branch of science is still acknowledged. Frazer, on the other hand, seems to be chiefly remembered among anthropologists for his impact on the public, not on the science. His conclusions are repudiated as not being confirmed by his data, and his data as being distorted and selected. (cf two reviews of Frazer's work in the Spring 1961 volume of Daedalus, one by E. L. Leach, the other by H. Weisinger.) Frazer, in other words, is accused of not organizing his data in the "scientific" way.

On the more extreme side, we might mention the work of Charles Fort, or of some of the modern "students" of flying saucers, or of any number of other collators and

(Continued on page 24)



ore than 450,000 pounds of thrust lifts the U. S. Army's Nike Zeus missile skyward in a cloud of vapor. The Nike Zeus missile being developed for the project by the uglas Aircraft Company will be designed to intercept ballistic missiles traveling over 15,000 miles per hour, and destroy them at a safe distance from the defended area.

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PEASE

(*Continued from page 22*)

organizers of data whose contributions have not been acknowledged as being of scientific value.

So when does collation and organization become science? Clearly this is a value judgment, and therefore within the area of philosophy.

Further, it may be said that science never, at any time, renders a value judgment. Hence, the use of science, in any area whatsoever, always involves a non-scientific judgment. Science may sometimes tell us that a given action will destroy the world or cure disease. But science itself will not say that these things are either bad or good. The scientific statements are ones of fact (if the science is correct) not of value. When the scientist says that therefore we should or should not do something, he speaks not as a scientist, but as a responsible human being. It is a conclusion of philosophy, not science.

We conclude, then, that truth is a unity, each part of which supports all others, even as it is in turn supported by the others. If we do not see the connection between different aspects of the total truth, it is only a measure of our ignorance. It is a measure of the incompleteness of our view of truth.

And we conclude, also, that there is no basis for assigning relative merit to different parts of truth. Different approaches to truth may have different values to the extent that they differ in the degree of their approximations to the truth, or in the scope of the partial illumination of truth that they provide. But this is a valuation of technique, not of truth itself, and is not relevant to the question.

Hence, we reject the implied judgment of the non-scientific philosophers that scientific truth is of less importance than the existential truths they seek. We reject it, not on the materialistic grounds of the utility of scientific knowledge, but on the purely philosophic ground that such a judgment is indefensible and self-contradictory.

This conclusion, then, denies the philosophic basis of the schism. In doing so, it opens the way to the next question of whether this fault really does any harm.

If the principle effect of the schism is to keep some fraction of the philosophers busy, the ultimate effect will probably be good. We can expect that there will be, eventually, a synthesis arising out of a combination of the two modes of thought. This synthesis will, in some manner, draw from both sides of the problem, and will be the richer for the diversity of its origin.

If, again, it provides a justification for the attitude of artists and others who will take those attitudes anyway because of temperament, then no harm is done. The philosophic schism will then simply put on formal grounds what is already fact. It will not affect either the actions of these people or the response of others to them.

But to the extent that it affects either the scientist-engineers themselves or the general public, then it is worth careful study to determine whether these effects are good or bad.

(*Continued on page 26*)

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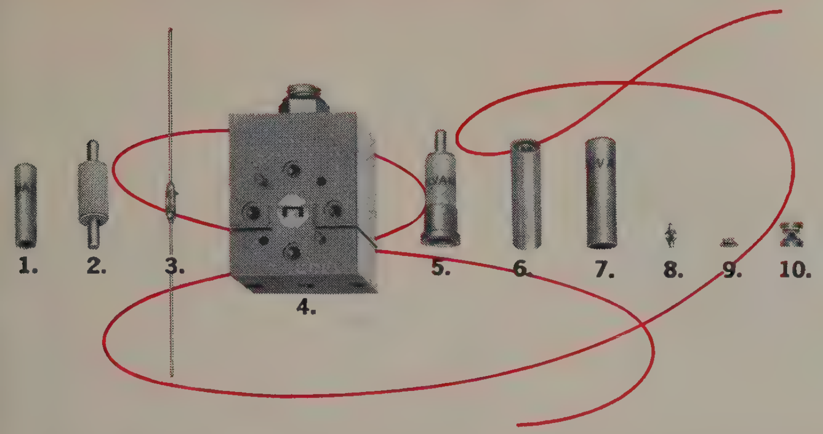
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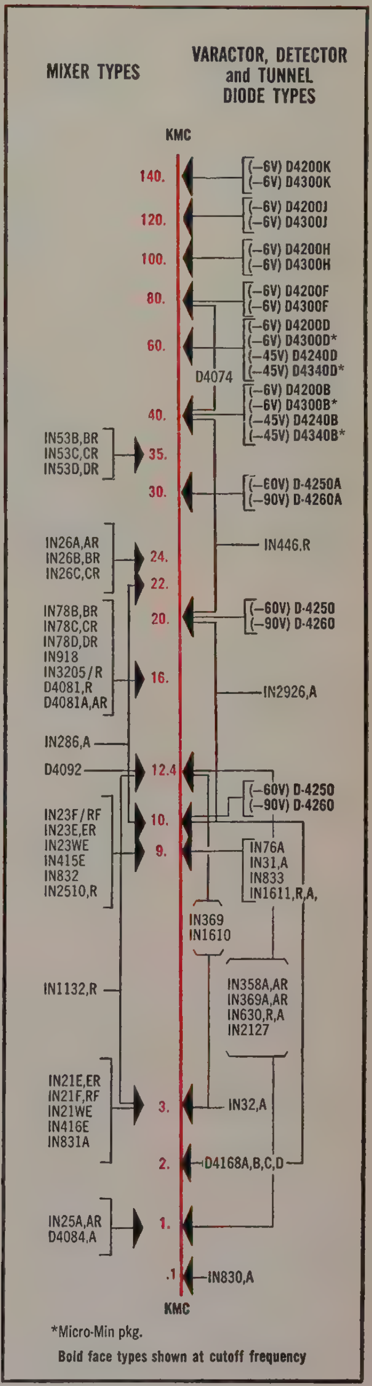
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(–6V) D4300K
(–6V) D4200J
(–6V) D4300J
(–6V) D4200H
(–6V) D4300H
(–6V) D4200F
(–6V) D4300F
(–6V) D4200D
(–6V) D4300D*
(–45V) D4240D
(–45V) D4340D*
D4074
(–6V) D4200B
(–6V) D4300B*
(–45V) D4240B
(–45V) D4340B*
IN53B,BR
IN53C,CR
IN53D,DR
(–60V) D-4250A
(–90V) D-4260A
IN446,R
IN26A,AR
IN26B,BR
IN26C,CR
IN78B,BR
IN78C,CR
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IN918
IN3205/R
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(–60V) D-4250
(–90V) D-4260
IN2926,A
IN286,A
D4092
(–60V) D-4250
(–90V) D-4260
IN23F/RF
IN23E,ER
IN23WE
IN415E
IN832
IN2510,R
IN76A
IN31,A
IN833
IN1611,R,A,
IN369
IN1610
IN1132,R
IN358A,AR
IN369A,AR
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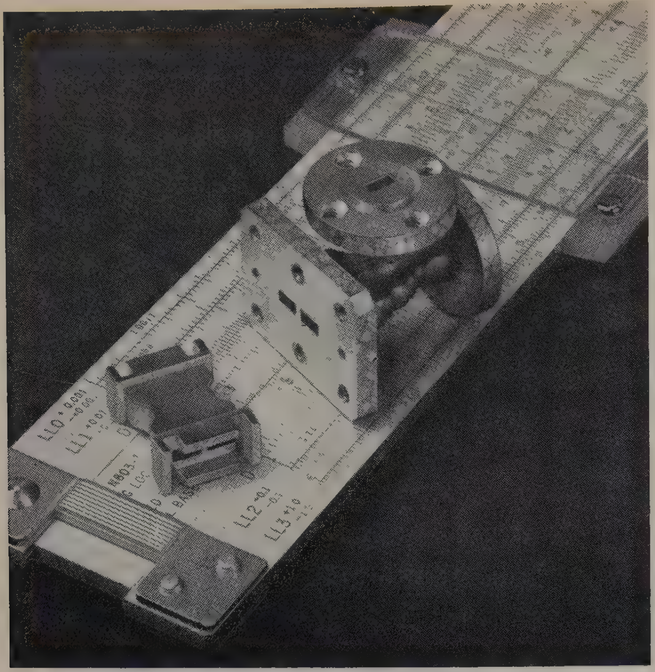

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PEASE

(Continued from page 24)

That it does affect the scientists is evident by their ambiguous and ambivalent response to the challenge. They do not, in general, accept the condemnation for if they did, they would not be scientists for very long. At least they would not be good ones. Scientific and engineering work is creative. A person cannot be creative if he does not have faith in the value of his work. But neither do they completely reject it. To the extent that they do not reject the condemnation, they weaken one source of inspiration.

As evidence that their rejection of the condemnation is less than total, we can observe the frequent use of the easy argument that science has created so many of the good things of the world. This is the pragmatic justification of science. While true, this argument is necessarily weak, since science has also laid the basis for many of the bad things of the world. Science cannot take credit for the one without responsibility for the other. Furthermore, the justification of science by its pragmatic results is precisely what the argument is about. This is a justification on materialistic grounds. It is an acceptance of the charge of materialism, and a transferral of the argument to the question of whether materialism is good or not.

The question of utility is, of course, one that must enter into any decision regarding the course of research or development. It is not, however, the only question. There is need for work that has no precisely predictable utility. The evidence is clear that, when such work is abandoned, science as a whole soon loses its momentum and becomes the sterile manipulation of insignificant detail.

Furthermore, since we are talking philosophy, we may argue that "pure" research (i.e. research motivated by other than utilitarian purposes) is vital to the growth of philosophy itself. Without it to provide a tie to the observable universe, philosophy degenerates into an interminable discussion of possibilities without means for decision. This was the fault of Greek philosophy, with some exceptions, with the result that the Greeks thought of many things and decided on nothing. There may be, at the moment, little connection between most of the existential philosophies that have been developed and the observable world of the scientist, but this simply asserts the existence of an unsatisfied need. It poses the problem, it does not deny it.

The proper philosophic justification of the work of the scientist-engineer is not simply the utility of his work, though this is a part of it. It is also as a search for truth. As far as the individual scientist-engineer is concerned, this aspect is, in existential terminology, an authentication of his own self.

To fail to recognize this aspect of the scientific motivation is to lose a vital source of inspiration. It is to accept the deliberate amputation of one of the major sources of creativity.

In the public area, the effect of this ambivalence is even

(Continued on page 28)

Here are two new -hp- couplers that can speed and simplify your reflectometer, mixing and power sampling work

761D DUAL DIRECTIONAL COUPLER
FREQUENCY RANGE 1000-4000 MC
HEWLETT hp PACKARD
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2-octave range for broadband convenience, minimum system reassembly
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IN POWER SAMPLING, flat coupling full range eliminates coupling corrections; you have, again, the convenience of one unit for both incident and reflected power, plus high power handling ability, low SWR and low insertion loss making practical a permanent monitoring installation in transmission lines.

SPECIFICATIONS *Model 760D, 250 to 1,000 MC,* mean coupling 20 ± ½ db, coupling variation ± ½ db, minimum directivity 35 db, primary SWR (max.) 1.20, secondary SWR (max.) 1.25, power capacity 50 w CW, 10 kw peak, Type N connectors, price, $200.00. *Model 761D, 1 to 4 GC,* same except directivity > 30 db, primary SWR 1.25, secondary SWR 1.30, price, $185.00.

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Model	Range	Minimum Directivity	Primary SWR (maximum)	Secondary SWR (maximum)	Price
764D	216-450 MC	30 db	1.10	1.20	$160.00
765D	450-945 MC	30 db	1.15	1.20	160.00
766D	940-1,975 MC	26 db	1.20	1.30	150.00
767D	1,950 MC-4.0 GC	26 db	1.25	1.50	150.00

Mean coupling 20 ± ½ db; coupling variation ± 1 db, power handling capacity 50 w CW, 10 kw peak; Type N connectors.

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PEASE

(*Continued from page 26*)

more obvious. One need only talk to a few supposedly well-educated people to realize that they have little conception of what science is. They have no recognition of either the goals or the limitations of science. They have a rather puzzled faith that science will ultimately answer all questions, including those for which there is no conceivable observable data. It is a puzzled faith because they do not see why some of these questions have not already been answered. And they believe that the essence of scientific progress is by a series of sensational break-throughs that suddenly reveal the answers to all their questions. Is the threat of war a problem? Let us set up a scientific program to study what to do about it. And if it does not yield an easy answer, let us make the program bigger. The more people working on it, the better the chance that some genius will come up with the single magic answer.

That scientists can help on this and other like problems is evident. The psychologists, sociologists, and anthropologists can isolate some of the pertinent factors, and perhaps suggest possible means of modifying either the factors themselves or their interactions. But it is obvious that the solution must ultimately lie in people or in their organization. The elimination of the causes of war must lie in a change either in the pattern of thinking of the people of the world or in their pattern of organization. It is a problem of education, in its broadest sense or of politics. The scientist can advise, but only the people can do. This is a distinction that the average person does not recognize.

The consequences of this misunderstanding are difficult to isolate or to foresee. It is a not-uncommon theme of science-fiction to consider a world which has revolted against science and deliberately reverted to a pre-scientific technology with those who insist on the value of science being lynched or otherwise discouraged. We may doubt that this will happen, at least on any general scale. Archaistic cultures do arise on occasion in the world, but they do not last. They cannot meet the competition of those peoples who have not embraced the archaism.

So we probably need not fear such an extreme resolution of the problem. On the other hand, the problem is probably going to be resolved sooner or later. The utilitarian aspects of science, the technology that it fathers, is having an ever-increasing impact on the world in general. Power is shifting, by design or by default, into the hands of those who have at least good intellectual contact with science. The problem has always had philosophic importance, but it is becoming pragmatically urgent. Sooner or later the urgency must force a resolution.

How will it be resolved? Evidently, there will be no magic answer to the question. It, too, will be a matter of education and of the evolution of thought. It will be a slow and sometimes turbulent development of a general awareness of the proper goals and built-in limitations of science, the recognition that science is a tool that must be understood if it is to be properly used by the philosopher, by the technologist, or by the people who seek its benefits.

It will only be when this has been accomplished that we will be able to call it truly the "age of science."

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NOW THIS VERSATILE PULSE MODULATOR IS AVAILABLE OFF-THE-SHELF

Radiation at Stanford (formerly Levinthal) capabilities in modulators are widely recognized. These quality standards are fully maintained in the Model 344M, a hard-tube pulser for klystrons, TWTs and magnetrons that affords maximum application flexibility.

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Here are a few specifications on the Model 344M Pulse Modulator:

• Peak power output	1.2 megawatts
• Peak pulse voltage and current	0-40kv, 0-30a to 5,000 pps 0-30kv, 0-30a to 10,000 pps
• Pulse width (90%)	0.1-5.0μsec continuously variable
• Maximum duty cycle	.002

For technical and performance data, write Radiation at Stanford, 3180 Hanover Street, Palo Alto, Calif.

RADIATION
at Stanford
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New B.F.Goodrich absorber helps increase radar coverage by 600%

All-weather panels eliminate radar-distorting reflections on jet aircraft guidance systems

THIS aircraft control guidance equipment is one of 183 in the U.S. Air Force network recently up-dated by Gilfillan Co., Los Angeles. The result? 600% more airspace now radar-controlled for safer guidance of USAF jets.

To cope with the more powerful equipment, B.F. Goodrich developed a new broadband absorbing panel to isolate the metal tower from the scanning of the antenna, thereby eliminating radar-distorting reflections.

As shown in the cutaway section, a 2″ thickness of BFG's hair-type absorber is permanently sealed into a fiberglass-covered aluminum panel. The assembly is completely waterproof, capable of long service in all weather conditions from the arctic to the equator. The light, strong, easy-to-install panels can be made in a variety of thicknesses to cover different frequency ranges.

In addition to use on guidance equipment, these BFG Type EN (enclosed) panels also improve the performance of communication and navigation systems, and increase the accuracy of outdoor testing ranges.

For more information on BFG microwave absorbers, send for our new booklet. Just write *B.F.Goodrich Sponge Products, 130 Derby Place, Shelton, Conn.*

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Model No.	Frequency (GC)	Max. Power Peak (Kw)	Max. Power *Avg. (w)	Insertion Loss (db) Max.	Isolation (db) Min.	Max. VSWR	Transmission Line	Connectors Input	Connectors Output	Dimensions (in.) L	Dimensions (in.) D	Weight (oz.) Approx.
D44L7	1.25 -1.35	5	5	0.9	15.0	1.20	5/8″ coax.	N Ma	N Fe	6 39/64	25/32	6¼
D44L7-6	1.435-1.535	5	5	0.6	16.0	1.15	5/8″ coax.	N Ma	N Fe	6 39/64	25/32	6¼
D44L33-25	1.7 -2.3	5	10	1.0	13.0	1.20	5/8″ coax.	N Ma	N Fe	9 15/16	25/32	8
D44L33-23	2.12 -2.305	5	5	0.7	13.0	1.15	5/8″ coax.	N Ma	N Ma	5¼	25/32	5
D44S7	2.7 -3.1	5	5	0.9	15.0	1.20	5/8″ coax.	N Ma	N Fe	4 11/32	25/32	5
D44C7	5.4 -5.9	5	5	0.9	15.0	1.20	5/8″ coax.	N Ma	N Fe	4 11/32	25/32	5

*Assume 2:1 Max. Load VSWR

BROADBAND LOW POWER

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Model No.	Frequency (GC)	Max. Power Peak (Kw)	Max. Power *Avg. (w)	Insertion Loss (db) Max.	Isolation (db) Min.	Max. VSWR	Transmission Line	Connectors Input	Connectors Output	Dimensions (in.) L	Dimensions (in.) W	Dimensions (in.) H	Weight (lbs.) Approx.
D44L5(72L2)	1- 2	10	10	1.0	10.0	1.25	5/8″ coax.	N Ma	N Fe	14⅛	1⅝	1 45/64	2 lb. 2 oz.
D44S5(72S2)	2- 4	10	10	1.0	10.0	1.20	5/8″ coax.	N Ma	N Fe	11 11/64	1⅝	1 45/64	1 lb. 7 oz.
D44C5(72C2)	4- 7	10	10	1.0	10.0	1.20	3/8″ coax.	N Ma	N Fe	6 7/16	1 41/64	1 23/32	1 lb. 4 oz.
D44X5(72H2)	7-11	10	10	1.0	10.0	1.25	3/8″ coax.	N Ma	N Fe	6 7/16	2¼	2⅜	1 lb. 6 oz.

*Assume 2:1 Max. Load VSWR

BROADBAND HIGH POWER

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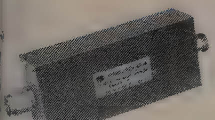
Model No.	Frequency (GC)	Max. Power Peak (Kw)	Max. Power *Avg. (w)	Insertion Loss (db) Max.	Isolation (db) Min.	Max. VSWR	Transmission Line	Connectors Input	Connectors Output	Dimensions (in.) L	Dimensions (in.) W	Dimensions (in.) H	Weight (lbs.) Approx.
D44L2-7	.95-2.35	10	200	1.0	10.0	1.25	7/8″ coax.	L-T Ma	L-T Fe	15⅜	2 1/16	3 9/16	5¾
D44L6	1.25-1.365	20	200	0.7	15.0	1.20	7/8″ coax.	N Ma	N Fe	11¾	2 1/16	3 9/16	5¼
D44S2	2.0 -4.0	20	200	1.0	10.0	1.20	7/8″ coax.	UG-46/U	UG-45/U	#12¼	2 1/16	3 9/16	4½
D44S2-5	2.35-5.0	10	200	1.0	10.0	1.25	7/8″ coax.	L-T Ma	L-T Fe	13	2 1/16	3 9/16	4½

*Assume 2:1 Max. Load VSWR

#Insertion Length

STRIP TRANSMISSION LINE



ALL NEW!

Model No.	Frequency (GC)	Max. Power Peak (Kw)	Max. Power *Avg. (w)	Insertion Loss (db) Max.	Isolation (db) Min.	Max. VSWR	Transmission Line	Connectors Input	Connectors Output	Dimensions (in.) L	Dimensions (in.) W	Dimensions (in.) H	Weight Approx.
D44J7	.400-.450	5	5	1.0	10.0	1.20	Strip	N Ma.	N Fe	7 37/64	3	1½	3 lbs. 7 oz
D44P1-5	.870-.990	5	5	1.2	20.0	1.20	Strip	N Ma.	N Fe	7 37/64	3	1½	3 lbs. 7 oz

*Assume 2:1 Max. Load VSWR

BROADBAND WAVEGUIDE

ALL NEW!

Model No.	Frequency (GC)	Max. Power Peak (Kw)	Max. Power #Avg. (w)	Insertion Loss (db) Max.	Isolation (db) Min.	Max. VSWR	Transmission Line	Connectors Input & Output	Dimensions (Length - Inches)	Weight (lbs.) Approx.
D41S5	2.6 - 3.95	10	10	1.0	15	1.10	RG 48/U	UG 53/U	11	12½
D41C5	3.95- 5.85	10	10	1.0	20	1.15	RG 49/U	UG 149 A/U	8	6¼
D41G5	5.85- 8.2	10	10	1.0	25	1.15	RG 50/U	UG 344/U	6⅛	3
D41X5	8.2 -12.4	10	10	1.0	30	1.15	RG 52/U	UG 39/U	6¼	2
D41U5	12.4 -18.0	10	10	1.0	30	1.15	RG 91/U	UG 419/U	*6	2

#Assume 2:1 Max. Load VSWR

*Tentative

Most of these units available from stock. We will welcome your inquiries for more complete information.

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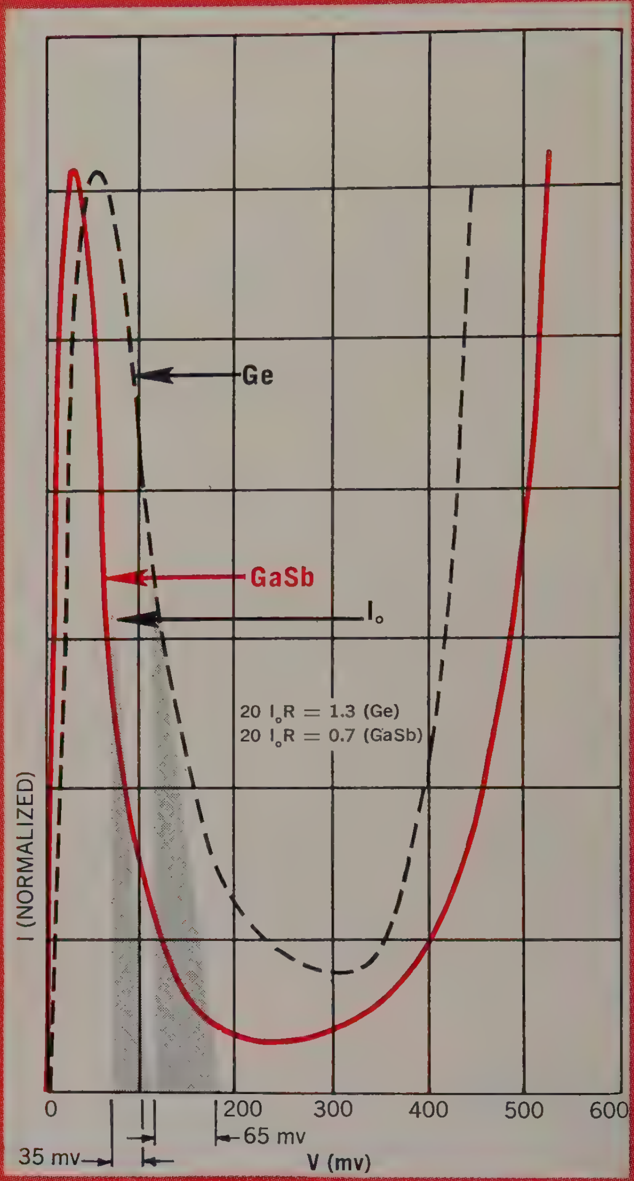
GALLIUM ANTIMONIDE TUNNEL DIODES

THE SHAPE OF LOW NOISE



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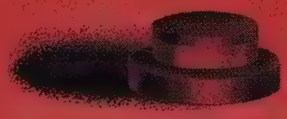
It has been shown that shot noise generated in the tunnel diode is the major factor contributing to amplifier noise figure. The shot noise constant, N_s, depends primarily on the shape of the I-V characteristic in the negative resistance region and has a value of $20\ I_oR$.

Values of the noise constant for Gallium Antimonide tunnel diodes are typically 0.80 while those for Germanium units are typically 1.30 and for Gallium Arsenide 2.4. Therefore, to obtain tunnel diode amplifiers with the lowest possible noise figures GaSb tunnel diodes must be used.

Micro State's Device Engineering Department will design and fabricate GaSb tunnel diodes to meet your specifications.

TYPE	MS 232	MS 233	MS 234	
I_P	1.0	1.0	3.0	ma ±10%
Noise Constant	0.80	0.85	0.90	max.
Capacitance	4	3	4	μμf typ.
Series Resistance	4	4	3	ohms typ.
Cutoff Frequency	2.5	3.5	4.5	Kmc typ.
Peak-Valley Ratio	12	12	15	min.



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DR. THEODORE MORENO

Vice President and Manager

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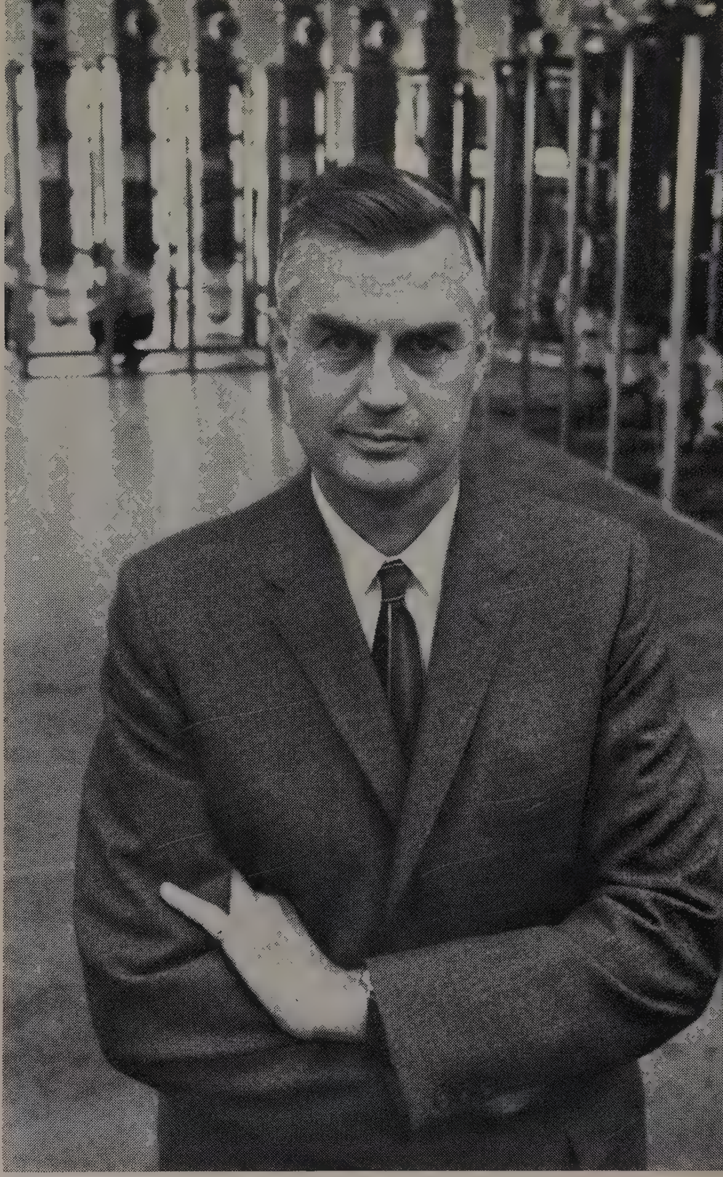

In the early 1920's when the late Russell Varian was an arnest undergraduate at Stanford University absorbing he knowledge that later led to the invention of the lystron, he saw almost daily a pre-school toddler who as destined to become an important figure in klystron echnology. The young student probably gave scant otice to the tot, youngest of Professor H. C. Moreno's hree sons. After all, the student was extremely busy nd the little boy was just the landlord's son. Behind the Moreno home was a tiny cottage which Professor Moreno ented to the struggling young student for a nominal fee.

Although the small boy and the student made little ontact then, their paths were destined to cross nearly wenty years later when both were immersed in a crash rogram aimed at providing America klystrons vitally eeded for a defensive weapon called radar.

The tot grew up to become Dr. Theodore Moreno, a an who has been in the forefront of many advances in he state of microwave art. Today he is vice-president nd manager of the Tube Division of Varian Associates, company founded by the young student who once ented Professor Moreno's cottage. But back in the 920's Ted Moreno was just a bright youngster enjoying ugely the benefits offered by life on the campus of Stanord University. He exercised his growing body in a ariety of sports, and spent long summers in the heady tmosphere of the Sierra mountains where hiking and shing were daily delights.

"Every summer I would head for the mountains, and wouldn't come down until school was ready to start gain," Dr. Moreno recalled.

Along with this love of the outdoors, young Ted howed obvious signs of high intelligence. This brought im to the attention of Professor Lewis M. Terman, a tanford psychologist who conceived the idea of selecting group of bright youngsters and following their lives o see what correlations there were between intelligence nd achievement. Intelligence tests on the youngest Moreno boy indicated his I.Q. was very high, and he uickly became one of what campus wags referred to as "Terman's Termites." Even today Dr. Moreno is occasionally visited and tested by researchers following up on Professor Terman's project.

Ted was reading by age four. He went through Palo Alto High School with honors, graduating at age 15. Considered a bit young for college, he spent the next year delving into a variety of subjects as a post graduate high school student.

"When I finally enrolled at Stanford, I just naturally went into engineering," he explained. "Both my older brothers had studied engineering and my father was teaching engineering mathematics. During my freshman year, I oscillated for a while between physics and electrical engineering. Finally, EE won out."

Dean Frederick Terman, head of the electrical engineering department and son of the famed psychologist who first noticed Ted's brilliance, described the youth as being well-integrated toward a goal. The "very-promising" label Dr. Terman affixed to Ted proved prophetic when he was graduated first in his department. He missed by a hair being first in his graduating class, being beaten for this honor by his own roommate. Along the way he was elected to membership in Phi Beta Kappa, Tau Beta Pi and Sigma Xi.

(*Continued on page 36*)

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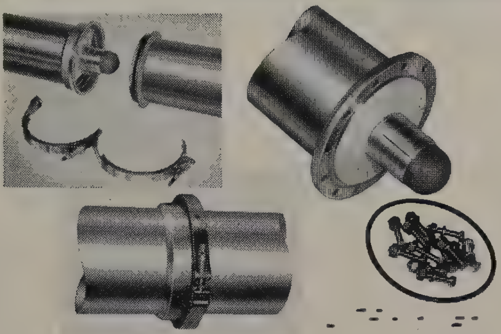
EVERY PERFORMANCE NEED



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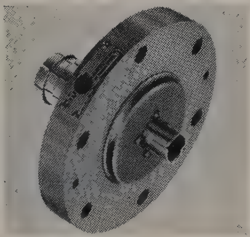
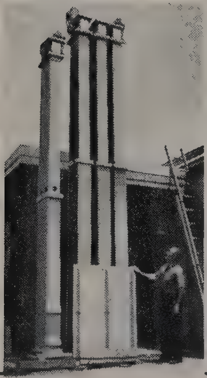
. . . in lengths up to 30 feet, copper or aluminum outer condu tors. Standard sizes are ⅞, 1⅝, 3⅛, 6⅛, $9\frac{3}{16}$ inches in standard impedances from 25 to 200 ohms. Special sizes a available such as 9, 10, 12, 16 inches. Two basic styles: Quic Clamp Type 40 featuring flange connections that swivel to a rotational angle, quick, positive assembly by tightening on two bolts, and piloted flanges eliminating centering rings; when specifications stipulate, the EIA (RETMA) Type bolted-flange lines offering the same electrical characteristic

QUICK-STEP REDUCERS & OTHER LINE COMPONENT

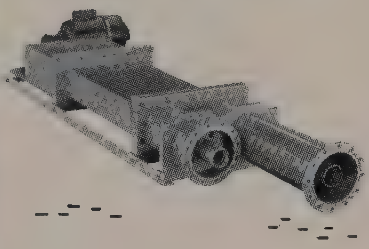


. . . *Dielectric's* Quick-Step reducers offer nearly perfect impedance characteristi in going from one line size to another, superior to cone-type reducers which occu much more space. Available for all Quick-Clamp and EIA (RETMA) rig transmission lines.

Other transmission-line components include 90° and 45° elbows, flexible section breakaway sections, adapters, gas stops, end seals, end covers, couplings, fie flanges, and supporting hardware.



PHASE SHIFTERS



. . . for any line size and impedance, and a degree of sophistication. Of particular intere is *Dielectric's* line of common-case, coaxial-li phase shifters which eliminate sliding joints the outer conductor. Power handling capacity a life are both enhanced.

Phase shifters are available in manual a remote-control models, with or without provisi for remote position indicating devices. All a characterized by low VSWR and wow, hi power capability, and variable, linear phase shi

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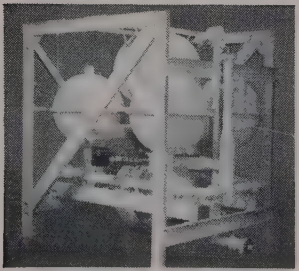
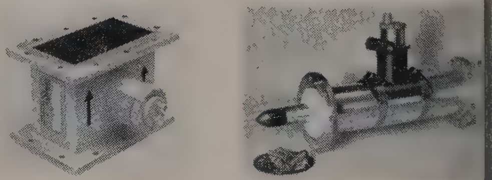


. . . for all applications, waveguide or coaxial. In addition to its standard line of single- and double-tuned coaxial resonators which may be combined in many ways, *Dielectric* designs special networks for any power level, low to very high.

Illustrated is a network to isolate 20 kw commands to and 0.002 microvolt signals from a space vehicle, simultaneously. Built for Space Technology Laboratories, Inc., one of these units is installed in the giant Jodrell Bank radio telescope. Also shown is a miniaturized balanced duplexer handling 10 kw average and weighing only five pounds.

DIRECTIONAL COUPLER



. . . provide for coupling external measu ing and monitoring equipment to coaxi and waveguide r-f transmission system The range of coupling ratio is rough 30 to 80 db, depending on model and fr quencies. Directivity of standard mode is $\geq$ 30 db, but $\geq$ 40 db can be supplie Output source impedance is 50 ohm Maximum power output is 4 watts f 3⅛" and larger coaxial models, 1 wa for smaller lines; 2 watts for 1½" x and larger waveguide, 1 watt for small guides.

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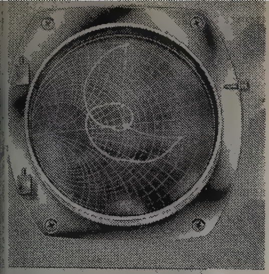

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. . . provide an instantaneous polar plot of reflection coefficient as a function of frequency (Smith Chart plot). Available are low-level coaxial models covering 10 to 3000 mc/s, low-level waveguide models covering 350 to 12000 mc/s, and high-level variations for system monitoring applications in both coaxial and waveguide transmission lines.

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. . for measuring VSWR to 1.002 accuracy,
he first and only major breakthrough in
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⅛", and $9\frac{3}{16}$" 50-ohm line sizes, other sizes
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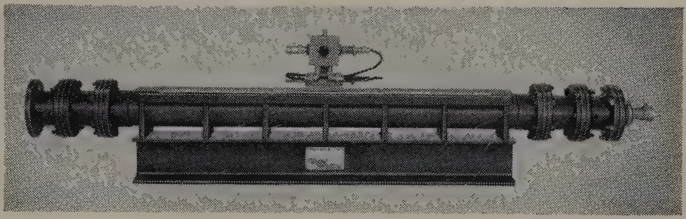
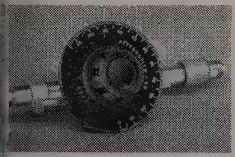
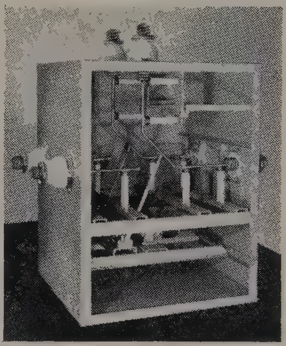


THER TEST EQUIPMENT



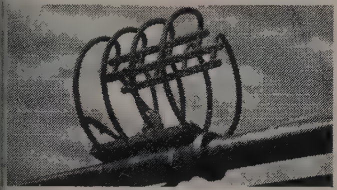
. . . available from *Dielectric* includes, for example, such diverse items as sliding loads for more accurate VSWR determinations, attenuators, and high-voltage generators. In addition to a coaxial attenuator, illustrated is a Marx generator capable of voltages to 600,000 peak dc, 400,000 sustained.

RF SWITCHES



. . . for coaxial line, waveguide, and open-wire applications ranging from small SPDT units with Type N connectors to a 4000 kw peak crossbar system 200 feet long. Illustrated is a DPDT open-wire unit manufactured for Page Communications Engineers, Inc., for the RADC Ava Transmitter Test Site: 425 ohms, 600 kw peak, 4-30 mc/s.

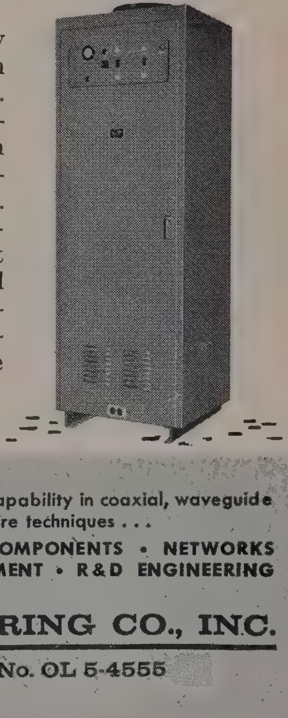
ANTENNAS



. . for mobile vehicular,
ixed station, FM broadcast,
nd high-gain communica-
ions applications. Illustrated
s one element of an FM
roadcast antenna, as well
s a 32 corner reflector ar-
ay for the Trans-Arabian
ipeline Company to provide
nulti-channel, over-the-
orizon communication.

DEHYDRATORS

. . . to provide very dry air for the pressurization of transmission lines. Available in a wide variety of capacities in both fully automatic and manually controlled models. Illustrated is a fully automatic model, a component of the ARSR-1A and ARSR-2 Air Route Surveillance Radars manufactured for the FAA by the Raytheon Company.



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MORENO

(*Continued from page 33*)

In addition to academic honors, he was captain of Stanford's water polo team and for two years was named All-Pacific Coast in this sport. The tall, muscular youth was frequently found on the team in such intramural sports as baseball, football and basketball.

After receiving his AB degree, Ted won a Charles A. Coffin Fellowship for graduate study. He was appointed a research assistant in the electrical engineering department at Stanford, and did original research on the use of leaky waveguide as microwave antennas.

Meanwhile, war had engulfed the United States. Scientists and researchers from quiet university laboratories all over the nation responded to the call. Russell and Sigurd Varian, W. W. Hansen, Edward Ginzton and others had left Stanford to join forces in a top-secret project aimed at giving U. S. forces radar eyes to guide them through darkness and help locate the enemy.

By 1942, when Ted took his masters degree at Stanford, bright young men who knew microwaves were badly needed. Along with others from Stanford, Ted joined the original Stanford group at Sperry Gyroscope Co. in Garden City, N. Y., where the new art of microwave technology was being spawned.

"The opportunity to work with and learn from Dr. Hansen was a strong factor in my decision to go to Sperry," Dr. Moreno recalls. "I had heard of the work he and the Varian brothers had been doing at Stanford; but I had been an undergraduate when it was going on, so I never got very close to it — so, in a way, this was the chance I'd been waiting for."

In those days the budding field of microwave technology was in ferment. New ideas and discoveries were spawned almost daily. An active worker in the field had to hustle if he wanted to keep up with everything that was going on. Sperry and the Radiation Laboratory at M.I.T. were focal points of this feverish activity.

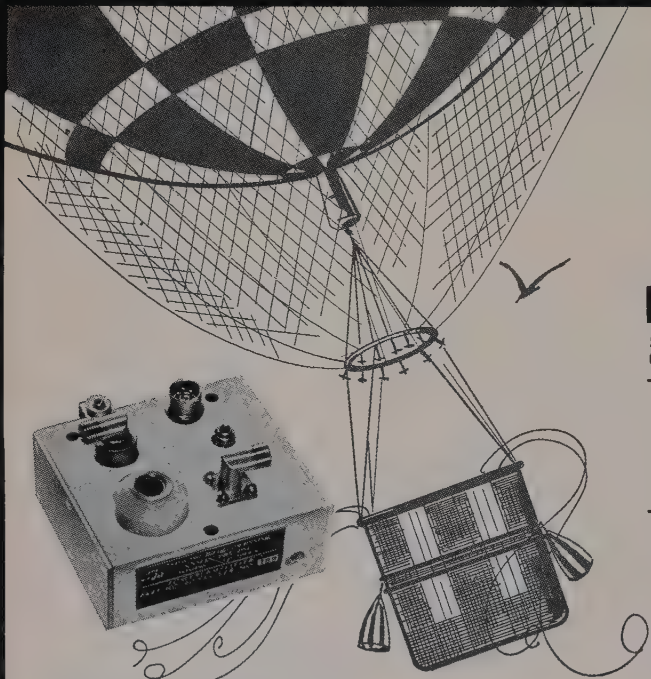
In an attempt to keep scientists and researchers informed about new advances in the field, Dr. Hansen divided his time between Sperry and M.I.T. He put in 16-hour days in order to lecture twice weekly to some 200 of the nation's leading physicists and engineers gathered at M.I.T. to find out all they could about this new field of microwave electronics.

Recognizing the value of these lectures, Ted Moreno edited Dr. Hansen's lecture notes, and compiled them into four volumes which today are prize possessions in the libraries of a lucky few microwave workers.

"Ted also recognized the need for some sort of collection of existing microwave knowledge, which was then spread out all over the place," recalls Oscar Lundstrom, a Varian microwave engineer who was working at Sperry during those war days. "He compiled the first comprehensive book about waveguide and cavity relationships."

That book, "Microwave Transmission Design Data," has gone through three printings by three different publishers since it appeared in 1944. One of the first, and best, books on microwave technology, it can still be found in well-thumbed copies in engineers' offices all over the world.

(*Continued on page 38*)



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DESCRIPTION: A-20 is a high gain amplifier; P-20 is a power amplifier. Heater supply is 6.3v @ .9a for both units.

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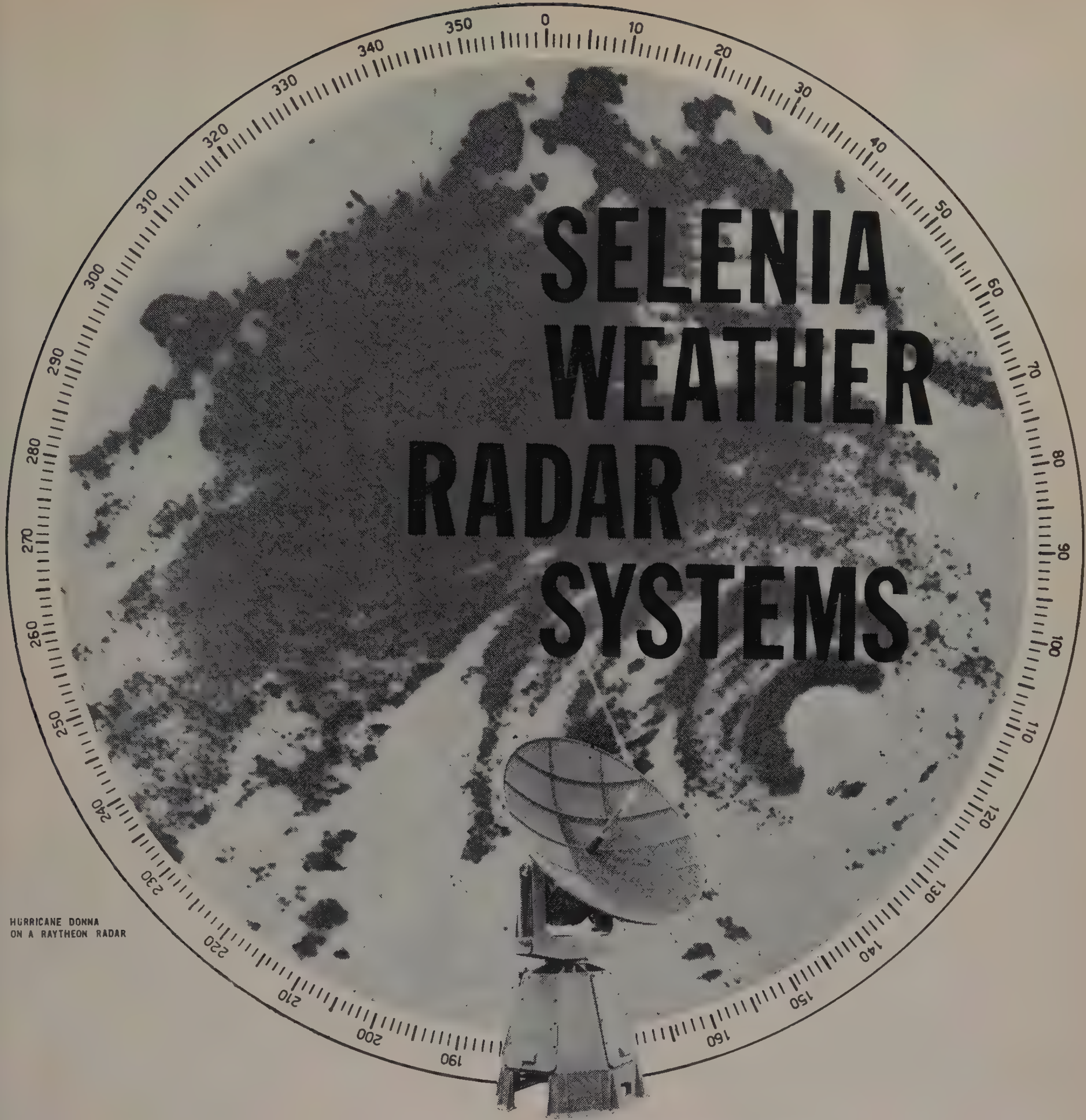

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MORENO

(*Continued from page 36*)

In those early days there was a great need for accurate methods and instruments for measuring microwaves and microwave phenomena. Ted was part of a research group that did pioneer work in this area. The group leader was Dr. Edward Ginzton, now chairman of the board at Varian Associates and director of the Hansen Laboratory at Stanford University.

Ted's analytical mind also turned to individual projects and he recorded a number of patents during his days at Sperry. One was for a crossguide directional coupler which has since become almost standard in the field.

"I could have made my fortune on that one," Dr. Moreno commented. The prolific young researcher also turned out items like a high frequency wattmeter, an ultra-high frequency directional coupling apparatus, an ultra-high frequency bridge and many other microwave devices.

All was not work, however, even during those war years. A frequent visitor at the home of Sigurd and Winnie Varian, Ted finally met the future Mrs. Theodore Moreno there. She was Winnie's younger sister, Lillian Hogg.

"Winnie and I grew up in Mexico, where our father was the British consul," Mrs. Moreno explained. "Sig met and married Winnie when he was flying in Mexico as a Pan American pilot. In 1944, I came to New York to visit them. That is when Ted and I met."

Courting a girl who lived two miles away during wartime gasoline rationing required some ingenuity and considerable determination. Ted solved the problem by riding a bicycle to his dates, braving bitter winter nights for a few hours with his girl. A short trip back to Mexico kept Lillian out of the country for four months. Her dual British-Mexican citizenship (she was born in a British consulate in Mexico) generated miles of redtape in the immigration department. Shortly after her return, Ted left for a 10-day trip. After weathering two separations, Ted proposed and was accepted.

They were married in Hempstead, N. Y., on June 23, 1945, with such noted microwave personalities as Russell and Sigurd Varian, Myrl Stearns and Ed Ginzton present.

"Ted figured that if anyone would do anything drastic to our honeymoon car it would be Ed Ginzton. And we couldn't have that, especially since we had borrowed the car from Ted's brother," Mrs. Moreno recalled. "Ted used reverse psychology and put Ed in charge of protecting the car from pranksters. Sure enough, everything came off without a hitch."

Knowing Dr. Ginzton's enjoyment of a good joke, Ted described this episode as "a gamble that paid off—luckily." The honeymoon was Ted's first vacation in four years.

After leaving Sperry in 1946, Ted began graduate work at M.I.T. His research there centered on cyclotron oscillator design and transmission techniques for millimeter waves. His doctor's thesis was entitled "On Transmission Techniques Suitable for Millimeter Waves." He was awarded the Sc. D degree in 1949 and took a job as research physicist with Hughes Aircraft.

At Hughes, the new Dr. Moreno did theoretical and design work on precision radio navigation systems and analysis work on various phases of guided missile development.

Dr. Moreno (right) discusses a cathode assembly component held by Robert Perry, tube development engineer.

By 1951 the budding firm of Varian Associates was in need of good microwave men. And Dr. Moreno was just the kind they were seeking.

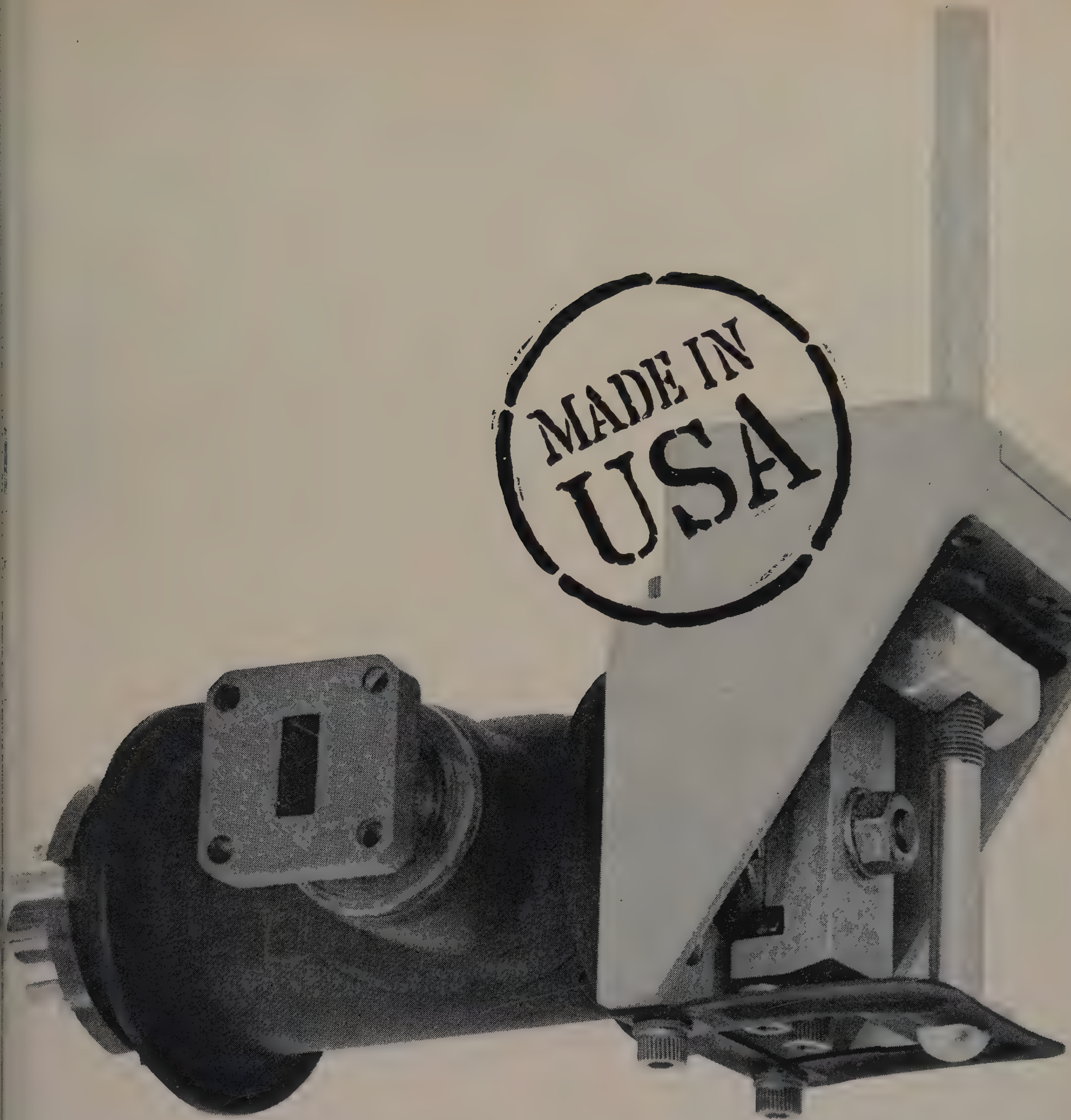
"The job was really made to order for me," Dr. Moreno said. "I knew many of the men in the company and had worked with them at Sperry. They were doing the kind of work I wanted to do, and the plant was located in my home town. What more could I ask?"

In those early days Varian employed about 100 people. The original research and development organization was beginning to expand into manufacturing. "We were so short of space and equipment my first desk was a sheet of plywood set up on sawhorses," Dr. Moreno explained. "We had so much work to do that everyone was trying his hand at everything. Over the years we have become so accustomed to such rapid growth that it seems normal not to have quite enough space for everyone and everything we need."

Hired as a senior engineer to work on klystron development, Dr. Moreno found himself moving more and more into administration. By the next year he was made department manager for tube design and development, directing several groups working on various problems involved in microwave tube design. During this period Varian pushed klystron development far beyond previous concepts. High-power pulse klystrons became widely used in radar applications, with Varian researchers pushing power levels up beyond what had once been considered feasible.

"Ted is the kind of administrator who understands what is needed by researchers. He likes to keep in close touch with the laboratory, and he is always up-to-date with any technical advances," Varian President, H. Myrl Stearns explained. "Best of all, he knows how to work with people."

(*Continued on page 40*)



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MORENO

(*Continued from page 38*)

Dr. Moreno likes to see engineers given full rein to try new ideas. Over the years the value of this kind of administration paid off. Varian engineers consistently stayed in the forefront of advances in such fields as high power continuous wave and pulse klystrons, and in rugged reflex klystrons for severe environmental conditions.

"Our successes can be attributed to the fact that we got the best men we could in various fields, provided them with the best tools to work with and gave them freedom to work out their own concepts of how certain technical objectives could be obtained," Dr. Moreno said.

In 1954 Dr. Moreno was elected to Varian's board of directors. In 1960 he was elected Vice President and appointed manager of the Tube Division, which contains about 50 per cent of Varian's 2,700 Palo Alto workers.

"I think one of Ted's strongest points is the absolute confidence he inspires in the people who work with him," explained Dr. W. J. McBride, Jr., now manager of Varian's Radiation Division and formerly a co-worker in the Tube Division. "He has a keen, analytical mind and makes his decision on the facts. Best of all, he is steady as the Rock of Gibraltar in his temperament."

Directing the research, development, manufacturing and sales activities for the world's largest dollar-volume producer of klystrons could be a nerve-racking job. But, apparently, Dr. Moreno handles his tough job without turning a hair.

"In 15 years of marriage he hasn't changed a bit," Mrs. Moreno says. "He never gets upset or cranky, and he always has time for the children." The oldest child, Fred, a 14-year-old who already displays some of his father's quiet seriousness, seems destined for a career that will utilize his obvious scientific and engineering interests.

"Right now, however, he is enthusiastic about racing cars and works in the pit crew for a family friend who likes to race," Dr. Moreno explained. "His career interests will jell later, I'm sure. I don't intend to influence his choice of a career in any way, other than to give him any help or encouragement he wants."

The two Moreno girls, Jacqueline, 11, and Nancy, 7, are completely wrapped up in school, camping and flying —not necessarily in that order.

Dr. Moreno's unruffled attitude toward his work may stem in a large part from the many outside interests he enjoys with his family. These include golf, bowling, camping and fishing. The latest family hobby is flying, which he and Mrs. Moreno learned so they could take the entire family into remote areas for genuine "away from it all" camping.

"Not long ago we flew up to Idaho and landed on a fire-fighters' emergency strip about 30 miles from the nearest road," Dr. Moreno said. "We found fishing spots where you could almost catch them with your hands. That's what I call a real vacation."

If the spirit of the late Dr. Lewis Terman is watching from some scholarly heaven, he probably is quite pleased with the achievements of this particular "Termite."

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Measuring phase shift of IF amplifier.
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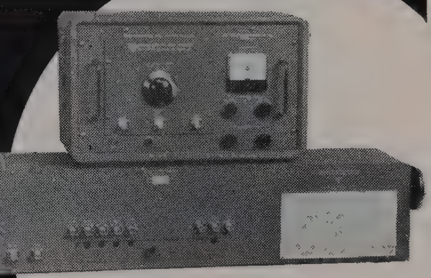

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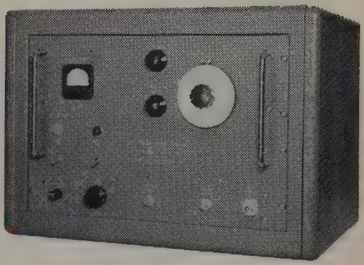

multi-purpose wide-range power sources

Sierra Model 215 series power sources cover 25 to 1000 mc in four instruments. They permit fast, accurate calibration of bi-directional power monitors and termination wattmeters, plus medium-power antenna measurements, interference measurements and other applications involving high attenuation of input signals. All have a nominal output of 50 watts, with output adjustable from 20% to 100% of rated power. Extreme stability facilitates repetitive or routine measurement, easy to use. Models cover, respectively, 25-50 mc, 50-150 mc, 150-470 mc, 470-1000 mc. $3,300.00 each.

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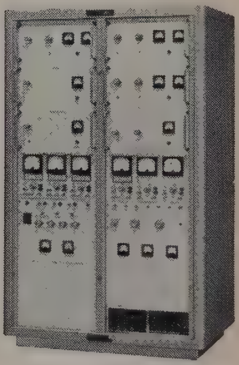
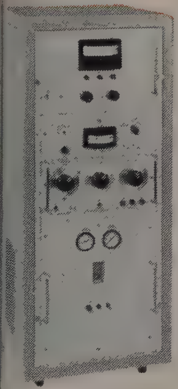
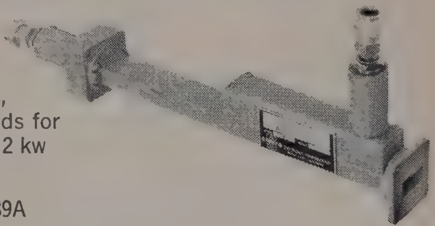
Six accurate, dependable power sources are available in the Model 1223 RF Calibration Test Set, which includes six power sources, six power monitors, power and frequency selector unit, blower unit, control unit and two regulated power supplies. Variable power to 125 watts at rf frequencies of 30, 100, 300, 400, 500 mc, to 60 watts at 1300 mc. Calibrates power-measuring devices to 1% accuracy (0.5% probable accuracy) $15,000.00.





Sierra calorimeters and mating water loads are available for both waveguide and coaxial applications. Model 290B, accurate to 1%, includes liquid flow controls, self-calibration sources, metering circuits. Dual water loads for balanced measurements include three waveguide models for C, XB and X bands, one coax model, dc to 4000 mc. Model 290B, $4,500.00.

Sierra Model 190A Calorimeter offers maximum power ranges of 300, 600, 1500 and 3000 watts. It provides a complete measuring system in conjunction with Model 186 Coaxial Liquid Cooled Loads, to 1000 watts, dc to 4000 mc; Model 187 series waveguide water loads for SL, S, C, XB and X bands, with average power limits 20, 10, 5, 3 and 2 kw respectively. Model 190A, $860.00. Loads, $275.00 to $600.00.



or applications where a complete Model 190A is not required, Sierra offers Model 189A ifferential Thermopile for use with 186 or 187 water loads. $85.00.

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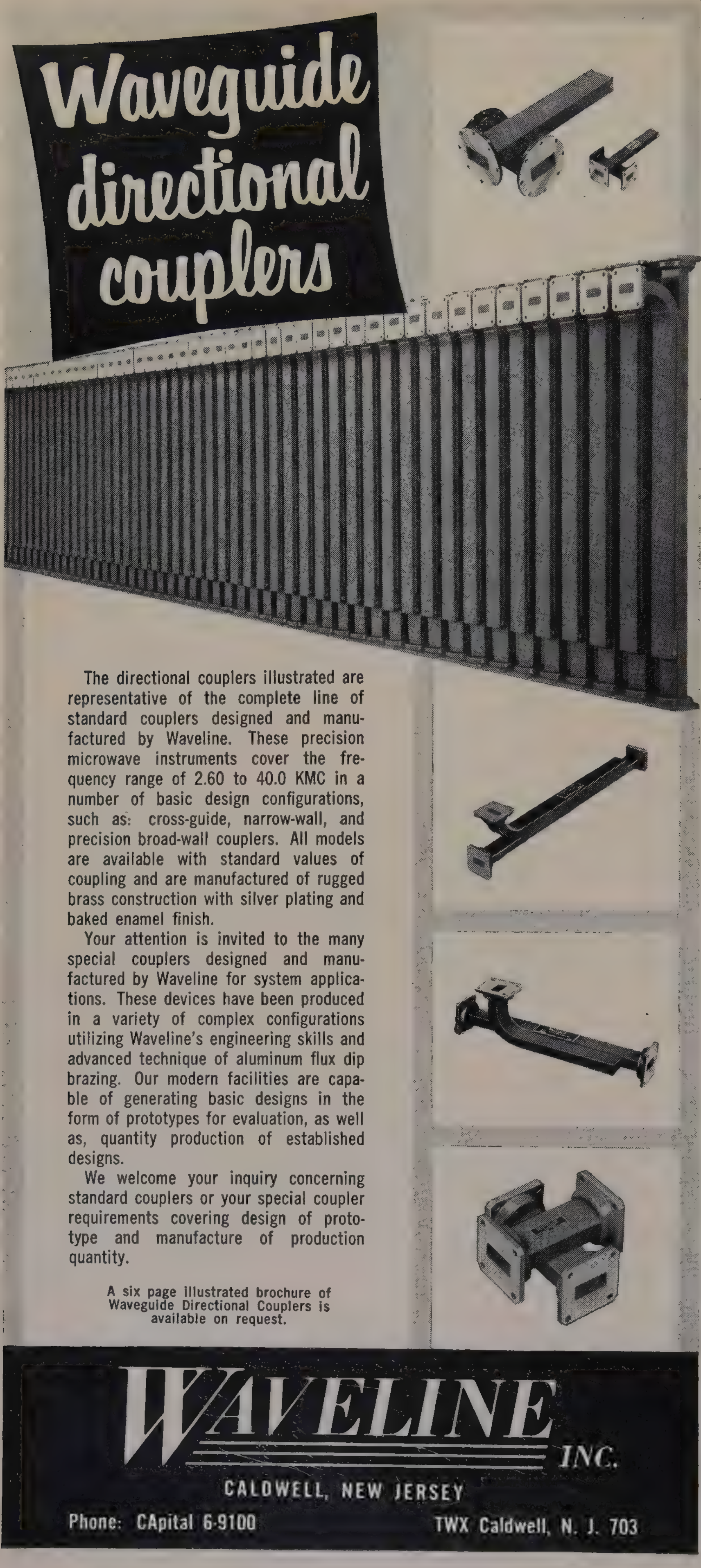

Waveguide directional couplers

The directional couplers illustrated are representative of the complete line of standard couplers designed and manufactured by Waveline. These precision microwave instruments cover the frequency range of 2.60 to 40.0 KMC in a number of basic design configurations, such as: cross-guide, narrow-wall, and precision broad-wall couplers. All models are available with standard values of coupling and are manufactured of rugged brass construction with silver plating and baked enamel finish.

Your attention is invited to the many special couplers designed and manufactured by Waveline for system applications. These devices have been produced in a variety of complex configurations utilizing Waveline's engineering skills and advanced technique of aluminum flux dip brazing. Our modern facilities are capable of generating basic designs in the form of prototypes for evaluation, as well as, quantity production of established designs.

We welcome your inquiry concerning standard couplers or your special coupler requirements covering design of prototype and manufacture of production quantity.

A six page illustrated brochure of Waveguide Directional Couplers is available on request.

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Industry News

(*Continued from page 17*)

TRAVELING INSTRUMENT EXHIBIT PLANNED

The second annual Electronic Instrument Manufacturers' Exhibit, a travelin technical show, featuring the latest developments of the nation's leading instrument manufacturers, will be held at seve eastern cities. The exhibit begins on September 21 in Syracuse, N. Y.

A new concept in road exhibitions, i will offer an operational array of laboratory and production-test equipment o seven manufacturers, whose products ar not only complementary to each othe but scientifically related. Selected instruments and accessories will be brought t carefully screened areas on a programme basis — areas found to be acutely activ in research, development, design and production requiring advanced instrumentation.

All of the booths, arranged to insur maximum exposure of the products, wil be manned by company-engineer specialists, providing an opportunity to obtai first-hand information on calibration an measurement problems in practically al areas of electronics.

This year's show will be under the sponsorship of General Radio Company Lambda Electronics Corp.; Non-Linea Systems, Inc.; Panoramic Electronics, Inc (formerly Panoramic Radio Products) Sensitive Research Instrument Corp.; Tektronix, Inc., and Trio Laboratories, Inc.

The seven touring-exhibit areas will be

Northern New York: Syracuse, N.Y
(Sheridan Inn) — Sept. 21

Connecticut: Norwalk, Conn.
(Norwalk Motor Inn) — Sept. 25

Long Island: Roosevelt Field, L. I.
(Sagamore Room) — Sept 27-28

Northern New Jersey: Cedar Grove
N. J. (The Towers) — Oct. 2

Pennsylvania: Philadelphia, Pa.
(Bellevue-Stratford) — Oct. 3-4

Central New Jersey: Watchung, N. J
(Wally's Tavern) — Oct. 9

Washington, D.C.: Washington, D.C
(Marriott Hotel) — Oct. 11

—mwj—

DR. NOVICK JOINS TUCOR, INC.

Dr. Gabriel Novick, formerly senior engineer at Westinghouse Electric Co., Baltimore, Md., has joined Tucor, Inc., a subsidiary of Trak Electronics Co., of Wilton, Conn., according to an announcement by Roger E. White, president of Tucor.

In his new position Dr. Novick will direct the analytical work associated with the product lines of Beacotron devices, traveling-wave tubes and gas plasma devices.

Specializing in the field of large signal

(*Continued on page 44*)

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Broad Band Antennas. Tamar has a completely instrumented antenna range and excels in the design of new-concept antennas, HF to 12 KMC, which are produced in quantity to precision specifications.

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Transmission Components. Special connectors, power dividers, phase shifters and other microwave components can be designed to your specific requirements.

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BWO calls signals for 3500 tube team

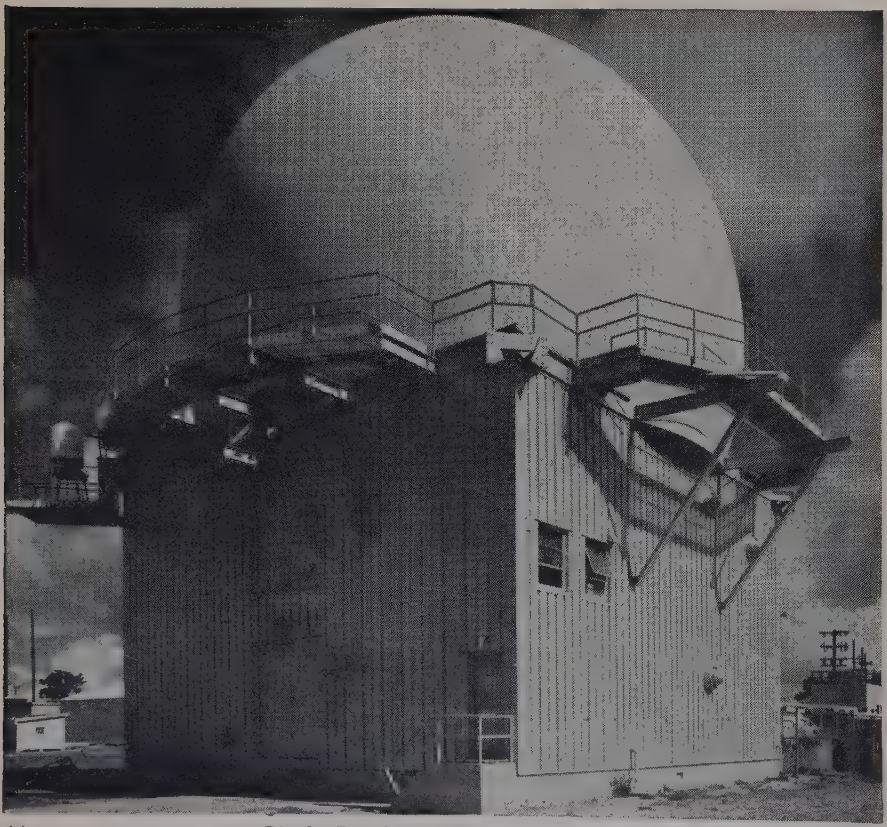
There are over 3500 tubes, diodes, and semiconductors in the new FPS-26 radar, each playing an essential role in the operation of this vital link in the SAGE continental air defense chain. But the responsibility of generating the signal that eventually beams skyward to measure the height of an incoming trespasser is entrusted to a single tube, a Stewart Backward Wave Oscillator.

The designers of the FPS-26 radar, the Electronics & Ordnance Division of Avco Corporation, selected a Stewart BWO because it showed up best in competition with other tubes, and because it was the *only* BWO available which would do the job. The parameters included extreme reliability, *1 kc short-term stability in the multi-Gc range,* and off-the-shelf availability.

Stewart, the only manufacturer devoted predominantly to the technology of BWOs, is geared to deliver production quantities of a full line of backward wave oscillators in the range from 1 to 40 Gc. Oscillators covering partial, octave, and greater-than-octave bandwidths can be supplied to meet your special requirements. Currently in development are permanent-magnet-focused tubes and metal-ceramic tubes, as well as conventional solenoid-focused oscillators. Write for details.

STEWART
STEWART ENGINEERING COMPANY
Santa Cruz 2, California

FPS-26 Radar installation at MacDill Air Force Base, Florida. Photo courtesy of Avco Corporation.



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Industry News

(*Continued from page 42*)

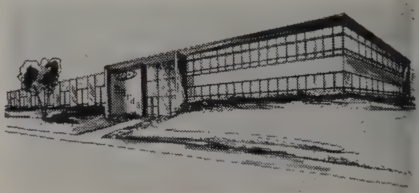
theory of traveling-wave devices and high efficiency collector designs, Dr. Novick's work at Westinghouse involved the improvement of high power traveling-wave tubes. Previously, as senior technical staff member at the Microwave Laboratory of General Electric Company, Palo Alto, Cal., he was engaged in research and engineering projects in external circuit cross-field amplifier tubes; the gridded Pierce-type electron gun; inverse cyclotron tube; and studies on the generation and suppression of harmonic and spurious frequencies in microwave tubes.

He received a degree in electrical engineering from the College of the City of New York, and obtained his MEE degree in electrical engineering at Polytechnic Institute of Brooklyn in 1949.

Dr. Novick is a contributing author on the subject of high order space harmonics in a volume entitled "Crossed Field Microwave Devices" which is scheduled for publication in late 1961.

—*mwj*—

NARDA LAYS CORNERSTONE FOR NEW PLANT



Narda Microwave Corp., Mineola, N. Y., recently laid the cornerstone of its new $500,000 plant at Engineers Hill, Plainview, Long Island. The new plant will double Narda's manufacturing capacity of components and test equipment for microwave and UHF communications systems.

Children participated in the cornerstone-laying ceremony to symbolize the youth and future growth of Narda.

Seven-year-old Mary E. Bourke helps her father, William A. Bourke, President of Narda lay the cornerstone of the company's new plant.

—*mwj*—

(*Continued on page 46*)

WIND STUDIES have shown it impractical in design to overpower wind in larger antenna structures. Answers are found through optimizing point of rotation for minimum torque. $P = \frac{KV^2w}{2g}$

VIBRATION STUDIES here have indicated methods of designing structures for high natural frequency with full regard for high response servo requirements. $f = \frac{1}{T} = \frac{\omega}{2\pi} = \frac{1}{2\pi}\sqrt{\frac{K}{m}}$

CONTOUR MEASURING STUDIES have led to the development of practical and accurate contour measuring systems applicable in all positions of the antenna. Advanced information has been gained in the fields of pointing accuracy and orthogonality error. $\delta = \frac{\Sigma(1\delta')^2}{\Sigma Nf}$

ENVIRONMENTAL STUDIES have provided extensive data on distortion and heat conduction properties of varying antenna structural shapes and materials. $\delta = \frac{\Delta t(\varepsilon)(l^2)}{h(8)}$

SURFACE PANEL TESTS prove that precise tolerances can be held in manufacture—as specified—regardless of panel type, material, size and structure. $\delta = \int \frac{Mmds}{EI}$

TRUSS EVALUATIONS of hoop stresses vs. radial stresses have demonstrated means of maintaining true contour under varying attitudes in both static and dynamic conditions for high frequency operation. $\Delta = \frac{\Sigma SuL}{AE}$

ROHR HAS THE FACTS

AND STRUCTURES EXPERIENCE TO BUILD PRECISION ANTENNAS THAT WILL MEET TOLERANCES

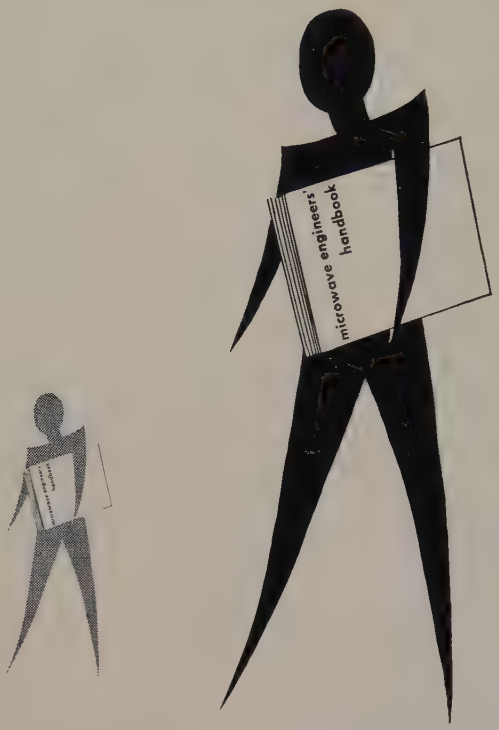
Months of intensive studies on many antenna problems together with a tremendous backlog of aircraft structures experience put Rohr in the position to precision-build large antennas better, faster, at less cost. And, we're ready to prove it. Research and development programs such as those shown above have given us the facts for production of better antenna structures. At the same time we have been manufacturing antenna structures of a major nature. Whatever the size—whatever the tolerance—whatever the technique—we'd like to discuss your antenna program. For Rohr has the facts—the facilities—the imaginative engineering—the metal forming experience to design and build antennas. For immediate and specific antenna information, please contact Mr. A. R. Campbell, Sales Manager, Dept. 64, Rohr Aircraft Corporation, Chula Vista, California. Main Plant and Headquarters: Chula Vista, California; Plant: Riverside, California; Assembly Plants in Winder, Georgia, and in Auburn, Washington

ROHR
AIRCRAFT CORPORATION

Circle Reader Service Card 33

the microwave engineers' handbook

and buyers' guide



If this HANDBOOK were to be sold over the counter, it would be a runaway best-seller among microwave engineers — but you don't have to buy it.

You may have a friend or colleague who wants and needs this invaluable engineering aid. Have him fill out a qualification card immediately and send it in. A copy will be sent without charge to all qualified *microwave journal* subscribers of record as of October, 1961.

He'll be eligible to receive the HANDBOOK, and he won't always be borrowing your journals.

HORIZON HOUSE, INC.
1330 Beacon Street
Brookline 46, Mass.

(*Continued from page 44*)

1962 ELECTRONIC COMPONENTS CONFERENCE SCHEDULED

The 12th annual Electronic Components Conference, sponsored by AIEE, EIA and IRE, and with participation by ASQC and the Society for Non-destructive Testing will be held in Washington, D.C. on May 8, 9, 10, 1962.

This meeting is devoted to new developments in components, component processing techniques, component evaluation and component materials. The following topics suggest the scope of interest:

Classical Components: R, L, C, linear and non-linear, lumped and distributed combined function devices: integrated thin film circuits, multiple semiconductor devices, miniature modules; solid state applications: ferroelectric, ferromagnetic, thermoelectric, magneto optic, electroluminescent; magnetics: square loop components, memory devices, magnetic films, magnetostrictive devices; electromechanical devices and concepts: switching devices, filters, delay lines; microwave components; filters and networks; connecting devices and techniques; processing, assembly and measuring techniques; non-destructive testing; component reliability; electronic materials; and component-systems planning and integration.

Papers representing original contributions in these and related fields are invited. Authors are requested to submit a 500-word summary before the October 9 closing date to:

Henry A. Stone, Chairman
Technical Program Committee
Bell Telephone Laboratories
Murray Hill, New Jersey

Authors will be notified of acceptance about November 15. Final papers will be due on January 15 and will be published in the Proceedings of the Conference.

—mwj—

MINIATURIZED SUBSYSTEM PROVIDED ASTRONAUT COMMUNICATION LINK

A miniaturized communication subsystem, essentially the same as the one aboard the Mercury Freedom 7 spacecraft, again provided the communication link for America's astronaut in the nation's second down range manned space flight.

Designed and supplied by Collins Radio Company, in co-operation with a team of eight subcontractors, the Mercury spacecraft communication subsystem included the following:

(1) Transceivers to provide voice communication in both flight and rescue operations.

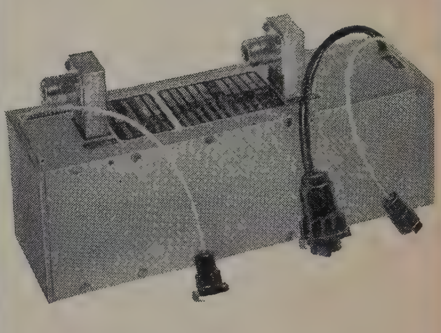
(2) Command receivers with a substantial number of on-off channels providing remote control for various functions within the capsule

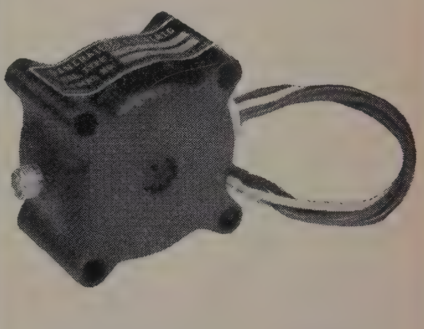
(*Continued on page 50*)

PROGRESS IN MICROWAVES

New General Electric TWT's and VTM's . . .

REDUCE SIZE, WEIGHT, AND POWER INPUT OF MICROWAVE RECEIVERS


ZM—3113—Low-noise, PM-focused TWT


ZM-6006—Low-noise, Lightweight VTM

Recognizing the need for microwave receivers of simpler design, the General Electric Power Tube Department continues to expand its line of light weight, compact, low-noise traveling-wave tubes and voltage-tunable magnetrons.

5-DB, S-BAND, PM-FOCUSED TWT
The most recent example of General Electric's progress in low-noise permanent-magnet TWT's is the ZM-3113, which has a nominal noise figure of 5 db over 2 to 4 kmc. Like other G-E traveling-wave tubes, this ruggedized TWT can be factory-optimized to provide even lower noise factors over narrower bandwidths. The ZM-3113 also has a signal gain of more than 20 db, and meets stringent military environmental specifications.

RAPID TUNING, BOWL-MAGNET VTM
Designed for local oscillator application on rapidly tuned radars, the ZM-6006 voltage-tunable magnetron operates over a frequency band from 2.8 to 3.2 kmc. It has a power output of 3 watts, a maximum voltage input of 1000 volts, and weighs only 1.5 pounds. Maximum noise figure for the ZM-6006 is −92 db in a 30 mc IF amplifier of one megacycle bandwidth.

Sample quantities of both the ZM-3113 TWT and the ZM-6006 VTM are now available with delivery in 90 to 120 days.

FREQUENCY RANGES AVAILABLE

LOW-NOISE TWT'S

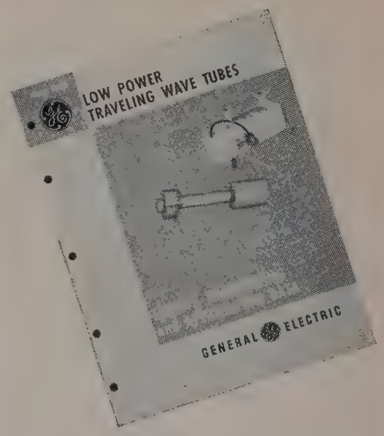
Frequency (KMC)	Maximum Noise Figure (db)	Minimum Gain (db)
2—4	6.5	20
4—8	10	25
7—11	10	25
7.5—8.5	7	25
8—12	10	25
14—18	14	25

LOW-NOISE VTM'S

Frequency (KMC)	P_o (Min. CW)
.5—1.0	.5 W
1.0—2.3	1.0 W
2.2—3.85	2.0 W
2.8—3.2	3.0 W

TO ORDER, or obtain more information, contact your nearest Power Tube Sales office (telephone numbers listed below).

265-11-9545-8481-43


LOW POWER TRAVELING WAVE TUBES

GENERAL ELECTRIC

For complete details on the theory, engineering, and application of General Electric low power traveling-wave tubes, write to Power Tube Department, General Electric Company, Schenectady, N. Y. Ask for bulletin PT-54.

POWER TUBE DEPARTMENT

GENERAL ELECTRIC

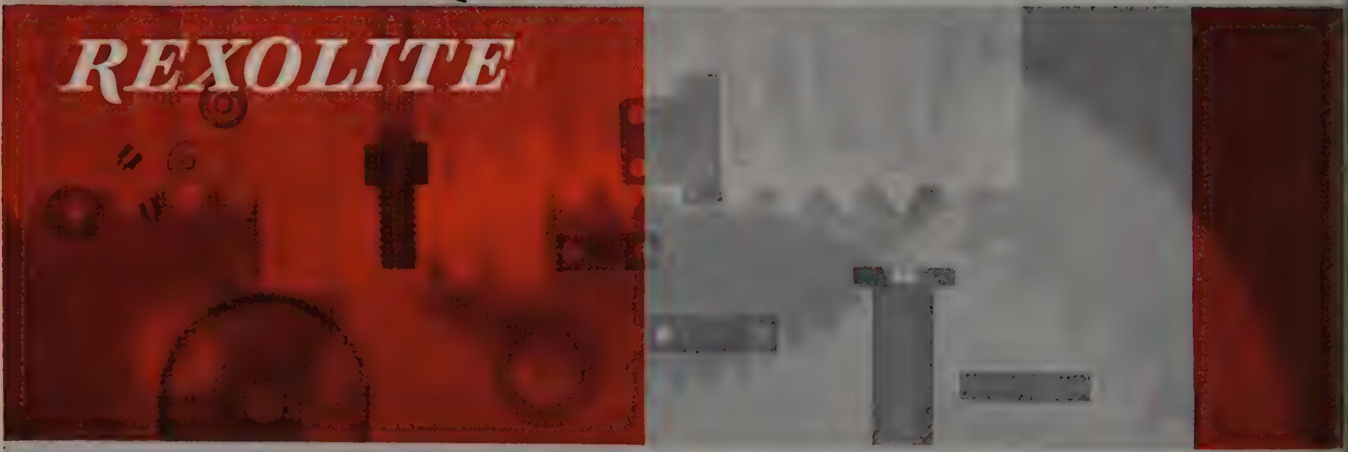
TELEPHONE TODAY—Syracuse, OL 2-5102 . . . New York City, WI 7-4065 . . . Clifton, N. J., GR 3-6387 . . . Washington, D. C., EX 3-3600 . . . Chicago, SP 7-1600 . . . Dayton, BA 3-7151 . . . Orlando, Fla., GA 4-6280 . . . Los Angeles, GR 9-7765

Rexolite® and Brand-Rex Technical Service Answer Most Microwave Insulation Problems

Across the microwave spectrum, from anode toppers to timing blocks; from antennas to duplexer pins, to filament cores, to light pipes, phaser assemblies and probe insulators; from slot arrays to slip ring disks and sweep arms, to transformer locks and cores, to timers and tubes . . . Rexolite plastic dielectrics and Brand-Rex technical service have teamed to stamp "solved" on a long list of complex microwave insulation problems.

And, it's an impressive reason why! Rexolite thermosetting materials offer a wide range of UHF electrical properties and advantages . . . low loss factor, low dielectric constant, and exceptional resistance to radiation. Pure research into dielectrics at the Enka Research Center in North Carolina and applied research and development by the Technical Development Group at the Acton, Mass., plant have resulted, and will continue to result, in significant new Rexolite types. Adding to its usefulness, Rexolite is available in rods and both plain and copper clad sheets which can be machined into an infinite number of simple or complex shapes.

BRAND-REX



A few minutes spent with samples and comprehensive Rexolite technical data will most surely be a profitable investment for you. Brand-Rex technical service engineers will gladly help, too. A note or call from you is all we need.

BRAND
REX

WILLIAM BRAND-REX DIVISION
American ENKA Corporation
DEPT. R, 37 SUDBURY ROAD, CONCORD, MASSACHUSETTS
Telephone: EMerson 9-9630

Vinyl, Teflon, Polyethelene, Nylon and Silicone Rubber Wires and Cables
Electrical Tubing and Sleeving — UHF Cast Plastics — Plastic Extrusions

Circle Reader Service Card 35

THE MTI MEASUREMENT PROBLEM

with particular emphasis on maintaining peak performance after installation.

by JAMES W. CHRISTIAN
Project Engineer, Instrument Division
LABORATORY FOR ELECTRONICS, INC.

The primary measure of quality of moving target indication (MTI) radar systems is subclutter visibility — the ability of the radar to see weak moving targets in a clutter of fixed objects. Since such systems distinguish between moving and fixed targets by detecting phase changes occurring in successive pulse repetition periods, all components affecting this distinction between targets must be highly stable.

MTI performance is limited by the fluctuation of signals from stationary targets (tree branch and leaf movement, internal motion of rain and snow clouds, etc.), scanning modulation, and imperfections in the radar system itself. Since the primary concern here is the measurement problem after design and construction, nothing can be done about the first limitation. And the second — scanning modulation (variation of the echoes from consecutive pulses as the antenna beam sweeps over a target) — is an unfortunate consequence of having an antenna pattern with sloping sides, mandatory if the radar is to provide azimuth information. Of the principal system imperfections, each is discussed in turn.

Within the system, unwanted amplitude modulation commonly results from gain changes caused by ripple voltages, and occasionally from unequal gains or nonlinearities in the delayed and undelayed channel amplifiers. However caused, any pulse-to-pulse amplitude modulation of fixed target signals impairs cancellation ratio, since these signals are not completely cancelled in the subtraction process at the output of the delayed and undelayed channels.

For high cancellation ratio, the video pulses from one pulse train to the next must be delayed for exactly the period between pulses. If not, a temporal mismatch exists which may be caused by a change in delay in the storage device, by drift of the pulse repetition rate, or by time jitter in the modulator triggering circuits. Whatever the cause, any impairment of cancellation ratio also impairs the subclutter visibility quality of the system.

The phase detector transforms signal phase changes relative to the coherent reference oscillator (coho) output into amplitude changes. Three oscillators are involved: the magnetron, the stabilized local oscillator (stalo), and the coho. Frequency instability of any of these leads to spurious pulse-to-pulse changes in the return signal phase, and impairs moving target visibility.

Since subclutter visibility is the primary measure of an MTI radar's usefulness, its measurement is of primary interest. One approach is to measure all of the instabilities of the system separately with component testers of one sort or another, and then to compute their effect on SCV (subclutter visibility). Even if all components seem within specifications, the larger question is unanswered or subject to error: "Does the system as a whole perform satisfactorily?" Also, complete measurements of this sort involve many disconnections, having the system out of service for a considerable length of time, and a wide variety of test instruments.

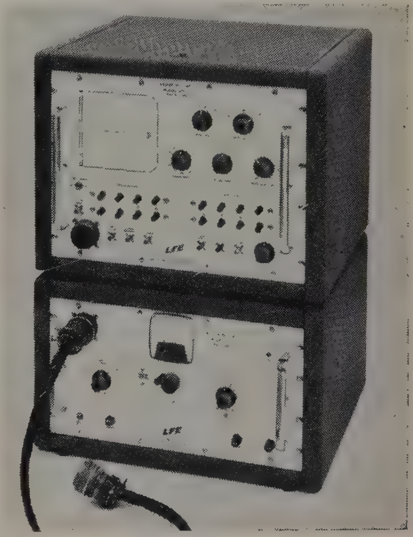
Another approach can be employed to measure SCV directly. Fixed targets of known characteristics can be erected, and aircraft of known reflection characteristics may be flown. However, this method involves an excessive number of people, much time, a communication problem, and great expense.

Both of these methods are so time consuming and expensive that the cost of routine maintenance checks becomes prohibitive. The unfortunate result may be poor operation when a system is needed most. Complete failure is obvious, but gradual deterioration may go unnoticed for days or weeks.

Fortunately, a test set for final production and maintenance thereafter is now available which measures SCV directly in one-tenth the time of any other method and at minimum inconvenience. Instead of yielding a numerical evaluation of individual component instabilities, this set isolates malfunction to one or more components and yields a direct measure of SCV at each level of measurement.

By producing simulated target pulses, fixed and moving, variable in amplitude, length, phase, and range, at r-f, i-f, local i-f, and video levels, the SCV in db can be progressively checked as shown for coherent radars in the block diagram. However, it is equally applicable to noncoherent systems.

The effects of scanning modulation and clutter fluctuation, factors external to the radar system, are beyond its function. However the set can be used to measure magnetron frequency and to align the radar set for peak performance.

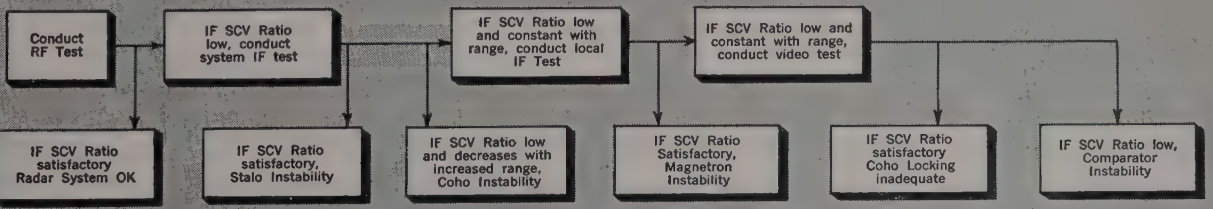


Model 5012

Available in L-, S-, C-, and X-band models, the LFE 5012 measures SCV to 40 db at r-f, and 40-50 db at i-f and video levels. One to 16 fixed, moving, or time-shared fixed and moving targets are consecutive or individually selectable in 5 nautical mile increments up to 80 miles. Signal phase is variable 0-360°. PRF range is 100 to 4500 pps, i-f input is 30 or 60 mc/s, selectable. For detailed specifications, description of the instrument, and full explanation of its operation, request Bulletin 5012. For this bulletin or particular information, write to Mr. Perry Pollins at the address below.

LABORATORY FOR ELECTRONICS, INC.
Instrument Division
714 Beacon Street, Boston, Massachusetts

TEST SEQUENCE PLAN FOR CHECKING MTI RADAR SYSTEMS


Conduct RF Test
IF SCV Ratio low, conduct system IF test
IF SCV Ratio low and constant with range, conduct local IF Test
IF SCV Ratio low and constant with range, conduct video test
IF SCV Ratio satisfactory Radar System OK
IF SCV Ratio satisfactory, Stalo Instability
IF SCV Ratio low and decreases with increased range, Coho Instability
IF SCV Ratio Satisfactory, Magnetron Instability
IF SCV Ratio satisfactory Coho Locking inadequate
IF SCV Ratio low, Comparator Instability

Note: Satisfactory SCV ratio is that which meets the radar manufacturer's specifications.

Circle Reader Service Card 36

When your specs require

connectors . . .

Use Gremar!

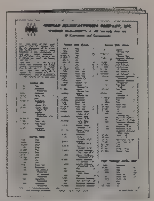
Gremar is geared to meet any requirement in RF connectors! And right now over 700 firms "Use Gremar" to meet their most critical needs.

Gremar is geared for leadership. This year alone we designed 500 new connectors! These include:
— 3 new rigid line series. Foamflex, Styroflex, Styrofoam Spirafil-T and Coaxitube lines.
— the new miniature Red Line series.
— the new Tefseal hermetic seal connectors that may eliminate glass seal types.
Now in R & D, we're working on new high temperature connectors . . . a new subminiature series . . . new radiation connectors . . . new high frequency connectors for K Band and beyond . . . new side-launch Stripline adapters.

Gremar is geared for delivery. Standards can be shipped in hours from our stock of 2000 types . . . 750,000 assembled units . . . 8,000,000 parts. If custom adapting to your spec's is required, we'll handle it with speed and efficiency unmatched in the industry. If it's a new design, our Model Shop will handle prototypes — *fast!*

**Military designation for RF Connectors.*

NEW 8 PAGE HANDBOOK
Just off the press! Latest listing of standard Gremar connectors and fittings. Send for your copy today . . . save time in specifying and ordering.



GREMAR
GREMAR MANUFACTURING COMPANY, INC.
WAKEFIELD, MASS., Tel. 245-4580
RELIABILITY THROUGH QUALITY CONTROL

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Industry News

(*Continued from page 46*)

during the launch, flight and re-entry phases when desired.
(3) Telemetry transmitters were provided to transmit scientific, operational and aeromedical data from the spacecraft to the ground.
(4) Radar transponder beacons in the microwave frequency range were used for precision tracking during flight.
(5) Rescue beacons. Two rescue beacons operating on internationa distress frequencies to determine the capsule's bearings during retrieving operations at sea.

Nearly every major function package in the communication subsystem was dupl cated and dual use of equipment provided redundant paths. For example, one of the telemetry transmitters may be keyed in an emergency to provide outgoing CW coded signals; the UHF voice-communication transmitter doubles as a direction finding beacon; and the command receivers are equipped with an emergency earth-to-capsule voice channel.

Collins designed and built equipment included the UHF voice transceivers, the HF voice transceivers, the communication control panel, the UHF rescue antenna, the Bicone isolator, the UHF voice power amplifier, the HF diplexer, the telemetry line filter and the HF antenna Z-match.

—*mwj*—

$330,000 IN NEW CONTRACTS AWARDED MICROWAVE ASSOCIATES

Microwave Associates, Inc., Burlington, Mass., announces the receipt of new contracts for research and development totaling more than $330,000.

The United States Navy, Bureau of Ships gave the Electron Tube and Device Division of Microwave Associates, Inc., a contract in the amount of $188,000 to conduct a high-power duplexer study.

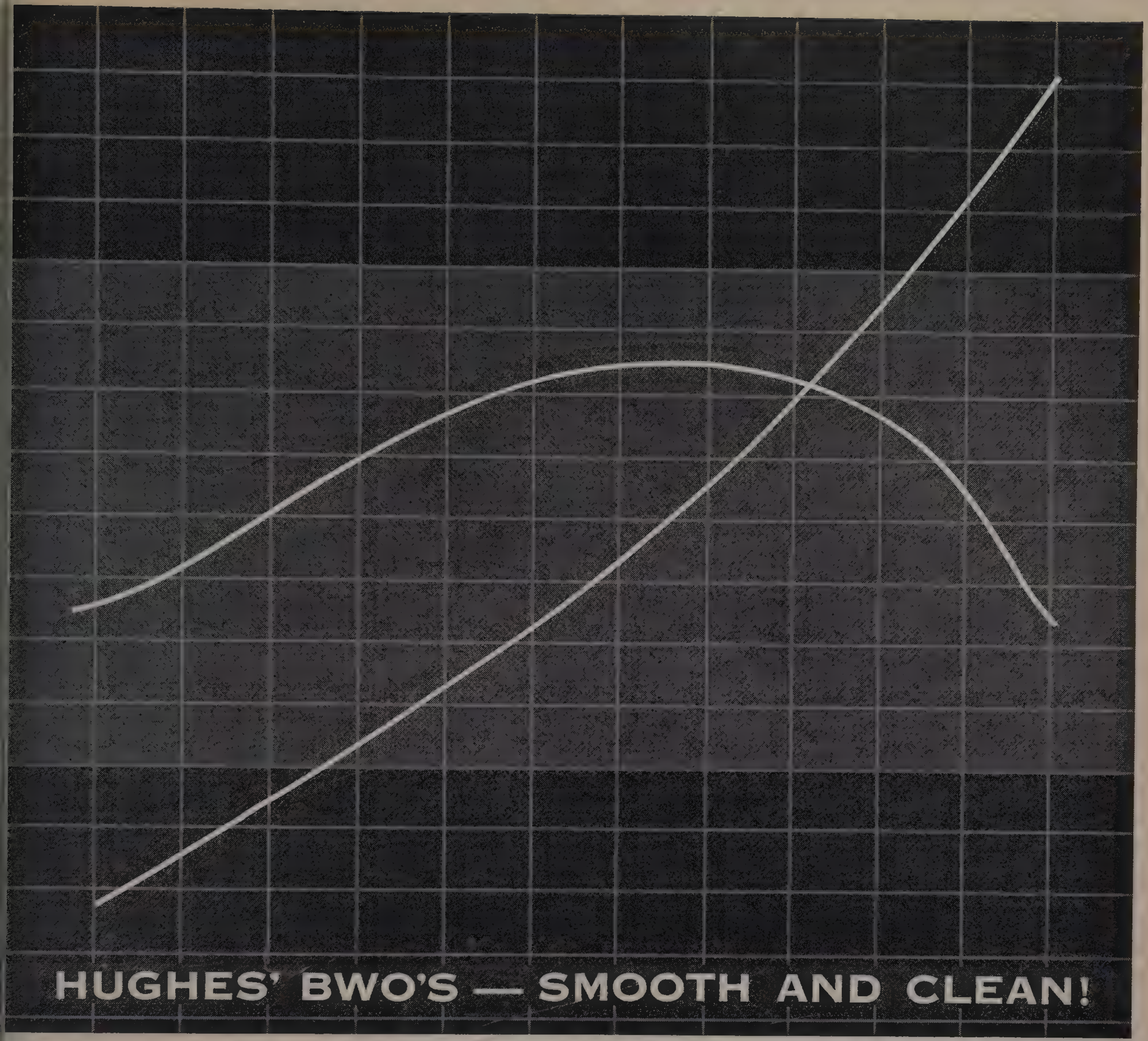
Another contract also awarded this Division was a $64,000 experimental research program to be conducted for the U.S. Air Force, Cambridge Research Center, Bedford, Massachusetts (Air Research and Development Command). It is concerned with development of microwave plasma amplifiers.

Two additional contracts from the Signal Corps., Fort Monmouth, New Jersey, were awarded the Semiconductor Division of Microwave Associates, Inc. Both involve research and development programs on microwave semiconductor devices. These contracts totalled over $78,000.

Award of these new research and development contracts brings the total of such research and development contracts received since April to over $1,000,000.

—*mwj*—

(*Continued on page 52*)



Hughes' BWO's are smooth and clean!

Smooth—because fine grain power output variations are less than 1 db. Extremely smooth tuning curves make AFC easy. ■ Clean—because signal outputs with spectrum widths as narrow as .05 mc are typical, with commercially available power supplies. In phase-locked loops, signals of width well under 1 kc have been obtained. Noise 30 mc off carrier in two 1 mc bands was -96 dbm in a typical case. ■ Also—Hughes' tubes feature non-intercepting grids, low pushing and pulling factors, stability in phase-locked operation, and very high signal-to-noise ratios. ■ Pictured below are four popular models, available for immediate delivery, which cover the frequency range from 7 to 20 kMc. Further information on these or any special requirements for BWO's may be obtained from Hughes MTD.

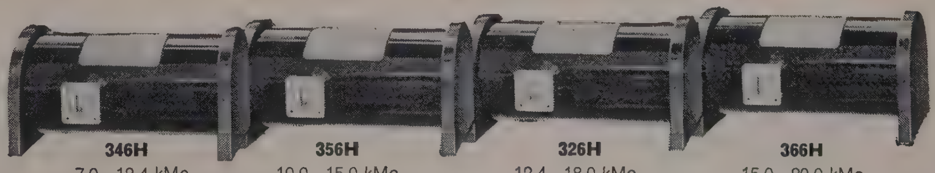
NORTHEASTERN 4 Federal Street, Woburn, Mass. WElls 3-4824 **EASTERN** 2000 "K" Street, N.W., Washington 6, D. C. FEderal 7-6760; 13 Lloyd Avenue, West Long Branch, N. J. CApital 2-1111 **WESTERN** 11105 South La Cienega Blvd., Los Angeles 45, Calif. SPring 6-1515

CREATING A NEW WORLD WITH ELECTRONICS

HUGHES

HUGHES AIRCRAFT COMPANY

MICROWAVE TUBE DIVISION



346H	**356H**	**326H**	**366H**
7.0—12.4 kMc	10.0—15.0 kMc	12.4—18.0 kMc	15.0—20.0 kMc
30 mw min P_o	10 mw min P_o	10—65 mw P_o	10 mw min P_o

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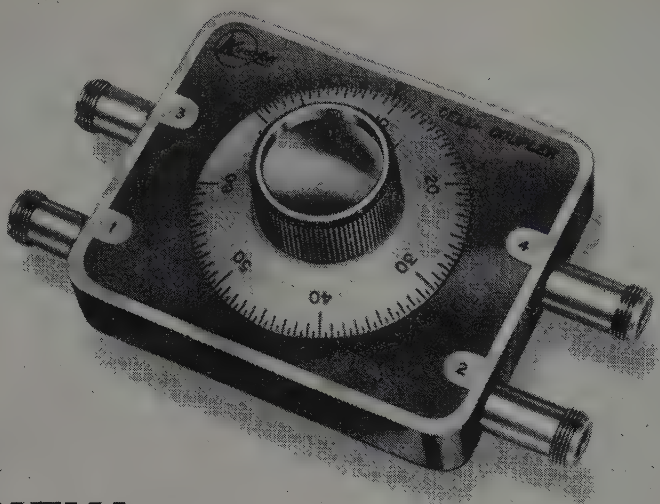

NEW DUAL-FUNCTION DELTA COUPLER

Kearfott's new broad band, precision calibrated variable directional coupler may also be used as a precision variable attenuator. Adjustable from 5 to 70 DB, it covers these ranges in either function. Accuracy is within ±1 DB of absolute attenuation over the specified range, and is displayed on a direct reading dial. Low USWR, low insertion loss and high directivity are inherent in the instrument.

AVAILABLE IN FOUR FREQUENCY RANGES

C99 1270001	500–1000 MC
C99 1270002	1000–2000 MC
C99 2270001	2000–4000 MC
C99 3270001	4000–8000 MC

Maximum average power handling capability: 200 watts

Write for complete data

KEARFOTT DIVISION
GENERAL PRECISION, INC.
Little Falls, New Jersey

Industry News

(*Continued from page 50*)

MOTOROLA AWARDED CONTRACTS FOR SATELLITE TRACKING INSTRUMENTATION

The Motorola Military Electronics D vision, Phoenix, Ariz., has received tw concurrent contract awards totalling $47 550 from the Philco Corp., contractor the U.S. Air Force, for precision satell tracking equipment.

The first contract involves a quantity UHF Doppler Tracking Receivers to b supplied by Motorola for installation Air Force tracking stations. These are be used in gathering critical distance velocity information from orbiting com munications satellites.

The second award is for a number Doppler and Monopulse Tracking Sub systems that will be used to update track ing systems now in service.

The tracking receivers to be supplie will be fabricated at the Company's Wes ern Center at Scottsdale, Ariz., under th technical direction of Mr. W. Culle Moore, head of the Center's Missile an Space Instrumentation Section.

According to Moore, the receivers em ploy a principle known as "phase-lock detection that greatly enhances their abilit to receive faint signals coming from ex tremely long distances. Phase-lock cir cuits of this type have been developed b Motorola for numerous missile and satel lite telemetry, command and tracking ap plications.

—*m w j*—

ITALIAN NAVY BUYS HUGHES 3-D RADAR

The Italian Navy has purchased Hughes Aircraft Co. Frescan 3-D rada system from the U.S. Navy and is instal ling it on the missile cruiser Garibald C. Harper Brubaker, company vice presi dent, has announced.

"Installation of the first electronic scan ning radar on the Italian cruiser will be completed this winter under the direction of Italian personnel," Brubaker said. A representative of Hughes' ground systems group is available at the installation site in Italy for technical advice.

"Frescan, developed by the U.S. Navy and Hughes and already operational on more than 20 of America's missile cruisers and destroyers, provides simultaneous 3-D pinpoint information of range, height, and bearing on many airborne targets with one antenna, transmitter, and receiver," Brubaker added.

It also features the first electronic stabilization to compensate for pitch and roll of a ship at sea. Three Italian representatives spent six weeks in training at Hughes' Fullerton, Cal. facility on the installation and operational procedure of Frescan. They were Major Francesco Chianura of the Italian Navy and civilian technicians Giorgio Diofili and Adalberto Depicolzuane.

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Circle Reader Service Card 39

LY APPOINTED ENGINEERING HEAD AT SPERRY

The appointment of Paul C. Ely, Jr. Engineering Head of Microline Operations has been announced by John H. Leutwiler, Division Manager of Sperry Microwave Electronics Company, Clearwater, Fla.

The entire line of Microline laboratory and factory precision measuring instruments now is ng handled by a separate, unified or- ization within the company, which is ponsible for every aspect of the Micro- e operation. Ely heads a team which responsible for all engineering phases Microline . . . from initial concept ough setup and tooling for manufac- e. Production and marketing groups nplete the integrated Microline organi- ion.

Ely, who received his BS in Engineer- Physics from Lehigh University, has n with Sperry since 1953, specializing the development, design and marketing commercial and military test equipment. member of the IRE and PGMTT, he is o active on the Calibration and Mea- ements Project Team of the Quality ntrol Committee of the Aerospace In- stries Association.

—mwj—

OAO SATELLITE TO USE RNE & MARGOLIN MICROWAVE COMPONENTS

Three microwave components (a di- xer and two hybrid junctions) devel- ed by Dorne and Margolin, Inc., estbury, N. Y., will accompany the AO (Orbiting Astronomic Observatory) ellite when it is launched by the Na- nal Aeronautics and Space Administra- n, it was announced by Arthur Dorne, esident of the company.

The 3000-pound satellite is to be put o a circular orbit around the earth at altitude of approximately 500 miles. e D&M microwave components will used in systems designed to control the entation of the OAO in space, and to ay the observed data to the ground. umman Aircraft Engineering Corp. is prime contractor.

As its name implies, the satellite will used to study the stars from a posi- n free of atmospheric interference. e version will mount a 36 inch tele- pe, and is expected to operate for at st a year.

The microwave components built by rne and Margolin are being designed withstand extreme temperature varia- ns, as well as the stresses and pressures ident to the launching process, while aintaining a 99.97 per cent reliability tor for the vehicle's operational life.

—mwj—

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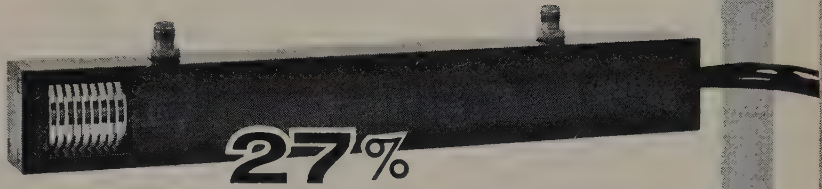

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EFFICIENCY
(including heater)

Intelligent design, high-grade materials, quality assurance and controlled processing at Watkins-Johnson have produced a family of efficient, light-weight and small size traveling-wave tubes.

Rugged, long-life, medium-power traveling-wave tubes, meeting the following typical specifications in S-band, are now available:

	WJ-227	**WJ-217**
Frequency	2.0—2.4 kMc	2.0—4.0 kMc
Power Output	12 watts	15 watts
Saturation Gain	35 db	35 db
Dimensions	1.4 x 13 in.	1.4 x 13 in.
Weight	2.5 lbs.	3 lbs.
Cooling	Heatsink	Air

Information in more detail available from representative in your area, or from

WATKINS-JOHNSON COMPANY
3333 HILLVIEW AVENUE
STANFORD INDUSTRIAL PARK
PALO ALTO, CALIFORNIA

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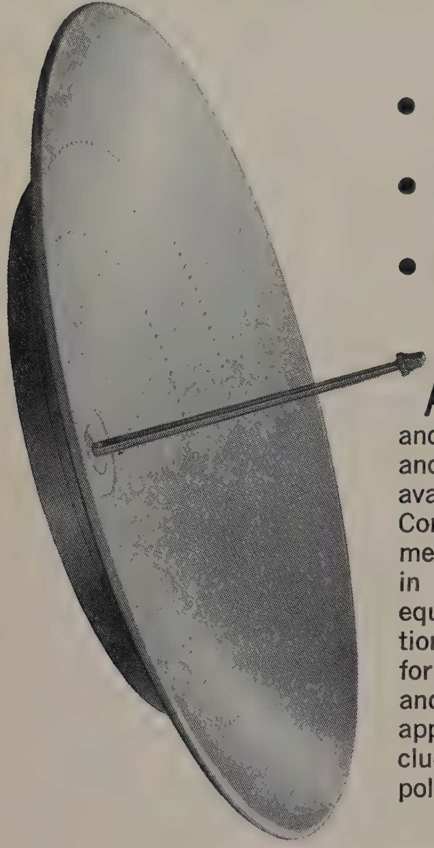
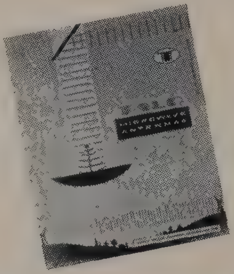
MICROWAVE ANTENNAS

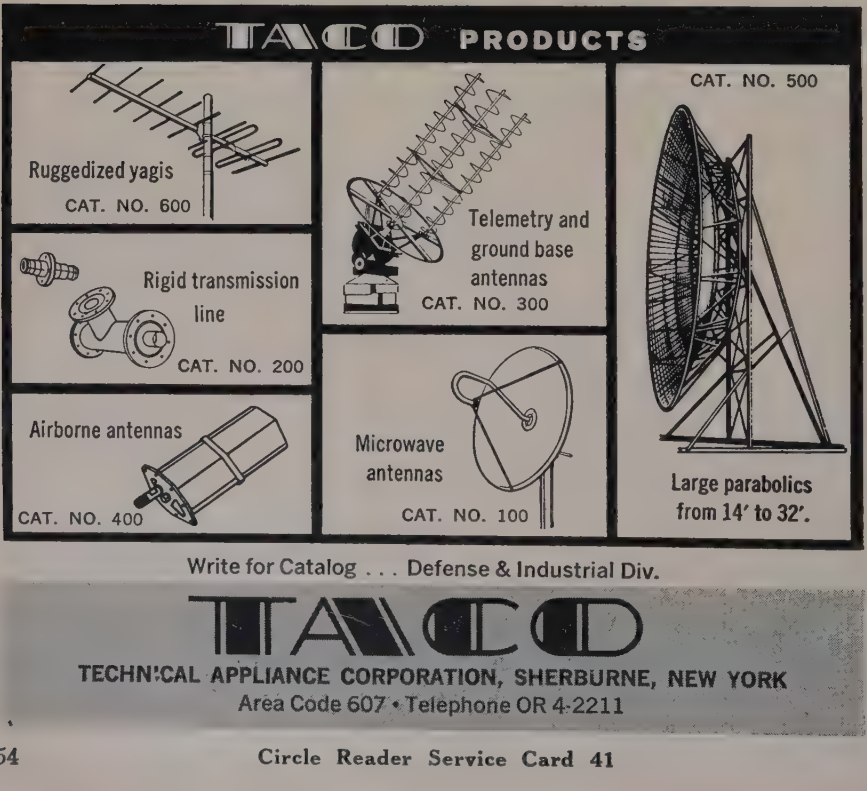


- *From 4′ to 12′*
- *All Mounts*
- *Choice of Feeds*

A broad line of Antennas, mounts, and accessories for the transmission and reception of microwave is now available from Technical Appliance Corporation. This new line of equipment represents the latest advances in performance and reliability. Taco equipment is ideal for initial installation or replacement use, as it is made for all commonly used commercial and military frequency bands, with appropriate feed characteristics, including dual polarization.



Be sure to see the complete story—SEND FOR CATALOG NO. 100



Write for Catalog . . . Defense & Industrial Div.

TACO
TECHNICAL APPLIANCE CORPORATION, SHERBURNE, NEW YORK
Area Code 607 • Telephone OR 4-2211

Industry News

(*Continued from page 53*)

PLASMA SHEATH SYMPOSIUM ANNOUNCED

The Second Symposium on *The Plasm Sheath — Its Effect Upon Re-entry Communication and Detection,* sponsored b the Air Force Cambridge Research Laboratories, L. G. Hanscom Field, Bedford Mass., will be held 10-12 April 1962 New England Mutual Hall, Boston.

The purpose of this symposium is th exchange of both classified and unclassified information on the problems of th transmission and reflection of electromagnetic radiation through the plasma shea which surrounds a hypersonic vehicle an their effect upon re-entry telemetry, communications, and radar detectability.

Specific topics include: 1. The Effec of the Plasma Sheath Upon Communications and Telemetry Systems of Re-entry Vehicles; 3. Techniques for Improving Re-entry Communications Systems; 4. Th Effect of the Plasma Sheath Upon Radar Cross-Section and Detectability; 5. Voltage Breakdown of Antennas at High Altitudes; and 6. Flight Test Programs and Instrumentation for Re-entry Communication Tests.

Both classified and unclassified paper are solicited on the above and related topics. An Abstract of approximately 200 words should be submitted to the address below prior to 15 October 1961. Th classified Abstracts should include an unclassified title for program use. Instructions for preparation of papers will be sent to each author.

Abstracts and requests for registration material should be submitted to:

Miss Alice Cahill, Code CRRD
Symposium Secretary
Air Force Cambridge Research
Laboratories
L. G. Hanscom Field
Bedford, Massachusetts

— m w j —

GE RECEIVES $36 MILLION NAVY CONTRACT

A $36,000,000 contract for production of the U. S. Navy's new AN/SPS-30 long range, height-finding radar has been awarded to the General Electric Company's Heavy Military Electronics Department, Syracuse, N. Y., it has been announced by Mr. Robert J. Brown, Department General Manager.

These new shipboard radars are for use on modern missile cruisers and carriers of the U. S. Fleet.

The prototype AN/SPS-30 was tested and evaluated at sea aboard the heavy cruiser USS MACON last summer. These tests were "highly successful" according to Navy officials and General Electric engineers.

The longest range height finding radar in quantity production for the Navy today, the pencil-beam AN/SPS-30, is designed to increase the anti-air warfare

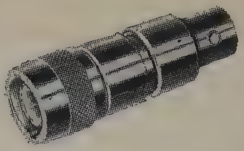
(*Continued on page 56*)

10,523 STANDARD COAXIAL COMPONENTS "ON THE SHELF"

IMMEDIATE DELIVERY FROM STOCK!

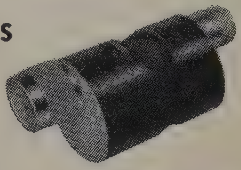
FIXED ATTENUATORS

DC to 12,000 mc
0 to 80 db
1.2 max. VSWR
2, 5, and 15 watts



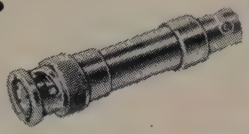
VARIABLE ATTENUATORS

DC to 10,000 mc
0 to 60 db
1.25 max. VSWR
Continuous or Turret



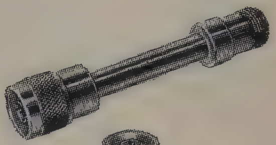
LOW PASS FILTERS

100 to 10,000 mc
1.3 max. VSWR
10 and 500 watts
Sharp cut-off.



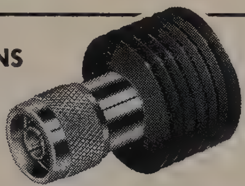
HIGH PASS FILTERS

200 to 6,000 mc
1.8 max. VSWR
10 and 50 watts
Sharp cut-off



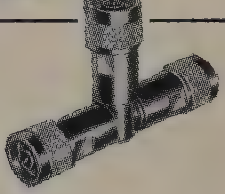
COAXIAL TERMINATIONS

DC to 13,000 mc
1.1 max VSWR
2, 10, 150 watts
Fixed and Sliding



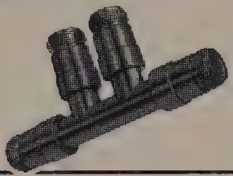
POWER DIVIDERS

DC to 10,000 mc
2 to 6 outputs
Resistive — wide band
Reactive — min. loss



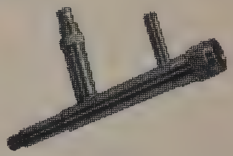
DIRECTIONAL COUPLERS

200 to 4,000 mc
Full octave Bandwidth
High directivity
Uni-bidirectional



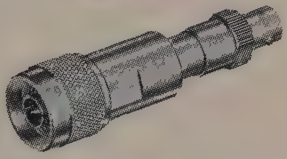
CRYSTAL MIXERS

250 to 8,000 mc
Single ended or balanced
1.5 max. VSWR
Adjustable L.O. Injection



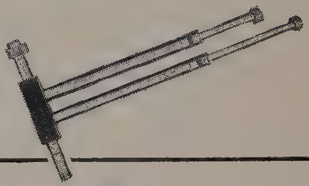
CRYSTAL MOUNTS

DC to 13,000 mc
Untuned, fixed tuned;
Padded; Tripolar
High Sensitivity



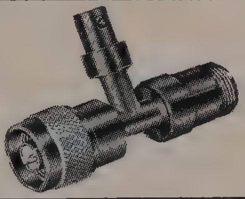
TUNERS

Stub Stretchers
Line Stretchers
Double Slug
Single, double, triple stub



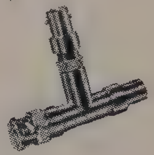
MONITOR TEES

Used to separate DC or video currents from an RF signal. Indispensable for monitoring helix intercept current in traveling wave tubes.



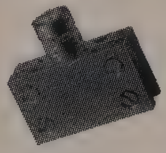
SIGNAL SAMPLERS

Used to monitor signals present in coaxial systems. Permits small signal to be taken from system without adding discontinuity. Coupling continuously adjustable.



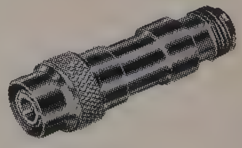
PRINTED CIRCUIT CONNECTORS

Side, end launchers
N, C, BNC, TNC
Screw-on or flange mounts.



DC BLOCKS/SHORTS

Sections of constant impedance transmission line with built-in blocking capacitor or DC by-pass.



- **All MICROLAB products are available FROM STOCK with Type N, C, HN, BNC or TNC male or female connectors.**
- **Special values, connector combinations and other special design features at same low cost and quick delivery.**
- **Prototype or production quantities at lowest cost.**

NEW CATALOG AVAILABLE

A new 72 page catalog listing thousands of stock coaxial components and product application information is now available from MICROLAB. Write on company letterhead for CATALOG NO. 10.

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MICROLAB

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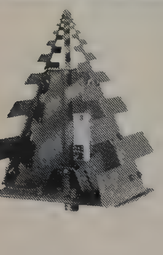
MICROLAB

Livingston, New Jersey   WYman 2-5700

FREQUENCY
INDEPENDENT
ANTENNAS



Model No. APN101A

LOG PERIODIC
LINEAR
POLARIZATION

Model No. ALN108A

CONICAL HELIX
CIRCULAR
POLARIZATION

MODEL NO.	FREQUENCY	MODEL NO.
APN105A	0.05-3.0 Gc	ALN112A
APN106A	0.3 -3.0 Gc	ALN119A
APN101A	1.0-11.0 Gc	ALN108A

The above AEL antennas represent an extensive line of both log periodic and patented conical helix antennas . . . all designed to meet today's dynamic requirements of electronic countermeasures, telemetering and communications systems.

High Gain, broadband performance can be obtained by employing the Conical Helix and Log Periodic feeds with parabolic reflectors. The fundamental limitation to gain-bandwidth of the parabolic configuration is defocussing caused by the phase center movement of the feed. In spite of this limitation, however, 15:1 bandwidths have been achieved with gains in the order of 15 to 30 db. Conical Helix or Log Periodic fed parabolic reflector antenna systems will be quoted on request.

Small volume—Light weight—Rugged Construction—Built for military usage

Investigate the opportunities at AEL for creative engineers

AEL

AMER. ELECT. LABS., INC.
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In Canada contact: Conway Electronic
Enterprises Regd. Toronto, Canada

(*Continued from page 54*)

capability of the fleet and will replace the General Electric-built AN/SPS-8 radars now in use aboard many of the Navy's combat ships. The first operational AN/SPS-30 is scheduled for delivery to the Navy in May 1962.

The AN/SPS-30, employing a mechanically stabilized antenna to compensate for roll and pitch of the ship, is capable of simultaneously determining direction, range and height of multiple airborne targets with extreme accuracy.

—mwj—

BALLISTIC MISSILE DEFENSE CONTRACT AWARDED TO RAYTHEON

The Department of Defense today awarded a $7,008,165 contract to the Raytheon Company, Lexington, Mass., to conduct a feasibility study of a new concept for ballistic missile defense called ARPAT.

ARPAT is one of a series of studies of possible ballistic missile defense concepts initiated and sponsored by the Advanced Research Projects Agency as part of its Project Defender.

ARPA has selected the U.S. Army Ordnance Missile Command at Redstone Arsenal, Ala., through the Boston Ordnance District to manage the ARPAT feasibility study.

Supporting Raytheon in the study program will be the following industrial team: Hughes Aircraft Company, the Boeing Company, International Business Machines Corporation, and the Bissett-Berman Company.

—mwj—

AVCO RECEIVES AIR FORCE RADAR CONTRACT

A contract for $28.5-million for follow-on production of the FPS-26 height finder radar has been received from the U.S. Air Force by Avco Corp's Electronics and Ordnance Division, Cincinnati, Ohio.

The huge radar units are used for continental defense by the U.S. Air Force. The FPS-26 determines the height of approaching aircraft with great accuracy at a distance of several hundred miles.

Avco, which engineered and developed the new radar, has had the equipment in production for several months. A few units have been delivered to the U.S. Air Force and are in regular operational use.

Major parts of the FPS-26 are built at the division's plant at Evendale, Ohio, near Cincinnati, and at Richmond, Indiana. The large radar reflector that is housed in a radome some 50 feet in diameter is built by Avco's Nashville Division in Nashville, Tenn. Avco also uses the services and equipment of more than 50 subcontractors in building the FPS-26.

—mwj—

RADIATION INC. GIVEN IMPORTANT ROLE IN DYNA-SOA PROGRAM

Radiation Incorporated, Melbourn Fla., has announced the receipt of a co tract from RCA for design of the groun antenna system for the Dyna-soar orbi rocket glider program.

The initial $600,000 funding will followed by a major contract in the "se eral million dollar range" covering a thre year period, Radiation officials reporte The company has thus been given an im portant role in the Air Force's Dyna-so program, as a subcontractor with respo sibility for the development of the highl complex and vital antenna networ "Breadboarding" or laying out the ele tronic design of the systems is being un dertaken at Radiation's main Palm Ba facility, only 25 miles from the launchin site, Cape Canaveral.

RCA was recently awarded the contrac as associate contractor for the Dyna-soa communications and data link subsystem Radiation joined RCA in a team bid sub mitted to the Air Force for the communi cations and data link subsystem.

The initial Radiation contract calls fo the design of two different types of an tenna systems, one to receive/track an the other to transmit. The entire antenn network will stretch over a vast distance with the majority of the stations locate along the Atlantic Missile Range corridor

—mwj—

REYNOLDS ELECTED TREASURER OF MITRE CORP.

Edward Reynolds, Jr. has been electe Treasurer of The Mitre Corp., Bedford Mass., it was announced by C. W. Halligan, president.

Mr. Reynolds replaces Mr. J. J. Snyder who resigned to devote his full attention to other business responsibilities.

A native of New York City, Reynolds received a BA degree from Harvard College in 1950 and a masters degree from Harvard's Graduate School of Business Administration in 1953.

Prior to joining Mitre as assistant treasurer in 1960, Reynolds served as assistant to the vice president and head of the contract administration department for Canadian Pratt & Whitney, Montreal —a subsidiary of United Aircraft Corporation. He was responsible for contract management for the company's aircraft engines, helicopters and electronic equipment.

He is a corporator of the Boston Five Cents Savings Bank and a Navy veteran of World War II.

—mwj—

(*Continued on page 58*)

ROHDE & SCHWARZ POWER SIGNAL GENERATORS

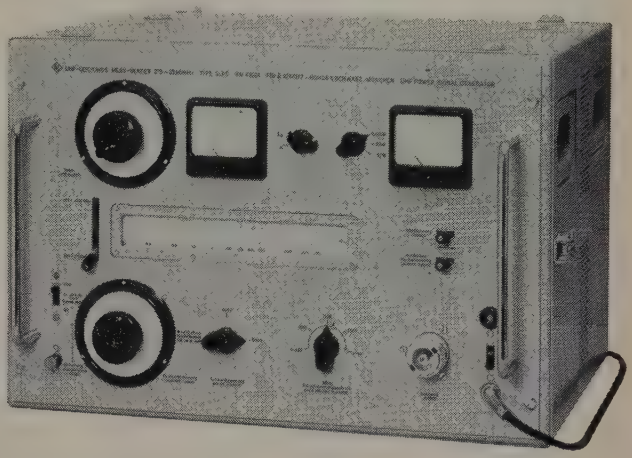
UHF POWER GENERATOR

275 mc to 2.75 kmc

- 20 watt maximum output
- Calibrated output meter plus 80-db attenuator
- Direct-reading frequency scale
- Band switch without interchangeable cavities

APPLICATIONS:

As a result of its high output power, among other applications, it will determine the radiation characteristic of aerials, measurements being carried out on filters and four-terminal networks of high attenuation or on wattmeters and directional couplers of high coupling attenuation and directivity. It can also be used as a generator for impedance, VSWR and attenuation measurements and for calibration procedures for which a known power is necessary.



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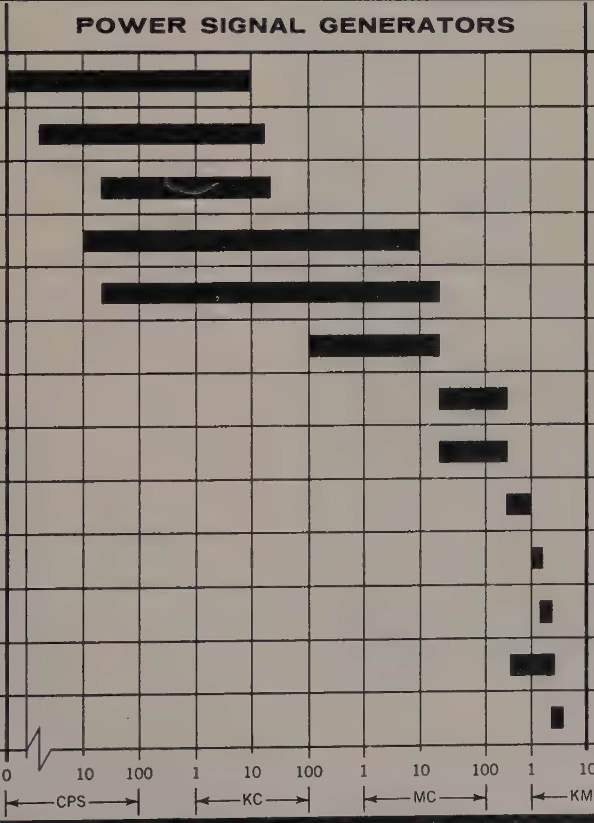


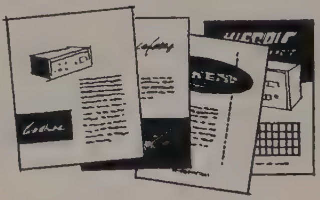
FREQUENCY RANGE	DESIGNATION
.0005 CPS to 10 KC	SYNTHESIZER XUB
2 CPS to 20 KC	GENERATOR SRN
30 CPS to 300 KC	GENERATOR SRM
10 CPS to 10 MC	GENERATOR SBF
30 CPS to 30 MC	SYNTHESIZER XUA
100 KC to 30 MC	GENERATOR SMLR
30 to 300 MC	GENERATOR SMLM
30 to 300 MC	MULTIPLIER XVD
300 to 1000 MC	GENERATOR SDR
1000 to 1900 MC	GENERATOR SCR
1700 to 2700 MC	GENERATOR SBR
275 to 2750 MC	GENERATOR SLRD
2700 to 4200 MC	GENERATOR SAR

For Highest Accuracy Requirements At Frequencies Up To 4200 MC

Our extensive line of power signal generators is the result of a quarter of a century of research and development in the electronic measuring field. It covers the frequency spectrum from millicycles to kilomegacycles.

All deliver large output in volts, offer very high frequency stability and accuracy, and have wide range attenuators. Excellent resolution is obtained by means of calibrated vernier. And incidental frequency modulation due to hum noise, etc., is extremely small.

All generators are installed in portable, rugged steel cabinets with removable front covers.



Write for detailed data sheets and demonstration

ROHDE & SCHWARZ
111 Lexington Ave., Passaic, N. J. • PRescott 3-8010

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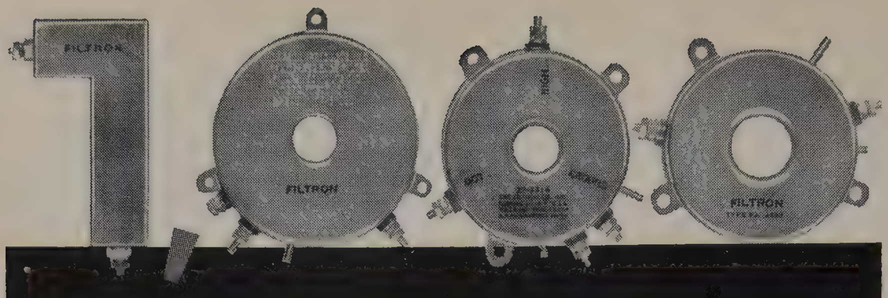

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FILTRON RF filters have suppressed unwanted interference signals virtually everywhere…in radar, electronic and electrical equipment…manned aircraft…missiles…satellites…weapons systems…launching platforms…and shielded laboratories too! These applications have required suppression throughout the entire electro-magnetic spectrum — from 30 cycles to over 50,000 megacycles—both broadband and narrow band. In all, more than 7,000 different types of Filtron RF interference suppression filters have been designed and manufactured under Filtron's exclusive patented circuit design. Millions are in use today.

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SPECIALTY CAPACITORS • DELAY LINES

RF INTERFERENCE TESTING • SYSTEMS ENGINEERING

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Industry News

(*Continued from page 56*)

VAN ATTA NAMED TECHNICAL HEAD AT HUGHES LABS

Dr. Lester C. Van Atta has been appointed technical director of Hughes Aircraft Company research laboratories at Malibu, Calif., Lawrence A. Hyland, vice president and general manager, has announced.

Dr. Van Atta recently completed a year's service in Washington, D.C. as special assistant for arms control for the director of defense research and engineering in the office of the Secretary of Defense. He was on professional leave of absence from Hughes during his government service.

Dr. Van Atta joined Hughes in 195 as head of the company's microwave laboratory, and later became associate director of the research laboratories, which then were located at the Culver City, Calif. headquarters.

Dr. Van Atta received a bachelors degree from Reed College (Portland, Ore.) in 1927 and a PhD degree from Washington University (St. Louis, Mo.) in 1931. Before joining Hughes he headed the antenna research branch at the Naval Research Laboratories.

He is a fellow of the Institute of Radio Engineers, where he is presently a member of the board of directors and previously served as vice chairman of the committee on professional groups. He is also a fellow of the American Physical Society, the American Association for Advancement of Science, and the American Geophysical Union.

—*mwj*—

ENDERS NAMED TO RCA DEFENSE MARKETING POST

William H. Enders has been appointed Manager, Advanced System Projects, of RCA's Aerospace Communications and Controls Division, Defense Electronic Products, it has been announced.

Mr. Enders will be responsible for marketing advanced military systems requiring the simultaneous application of a number of technical skills. He formerly was Administrator, Market Research and Analysis, for the same division.

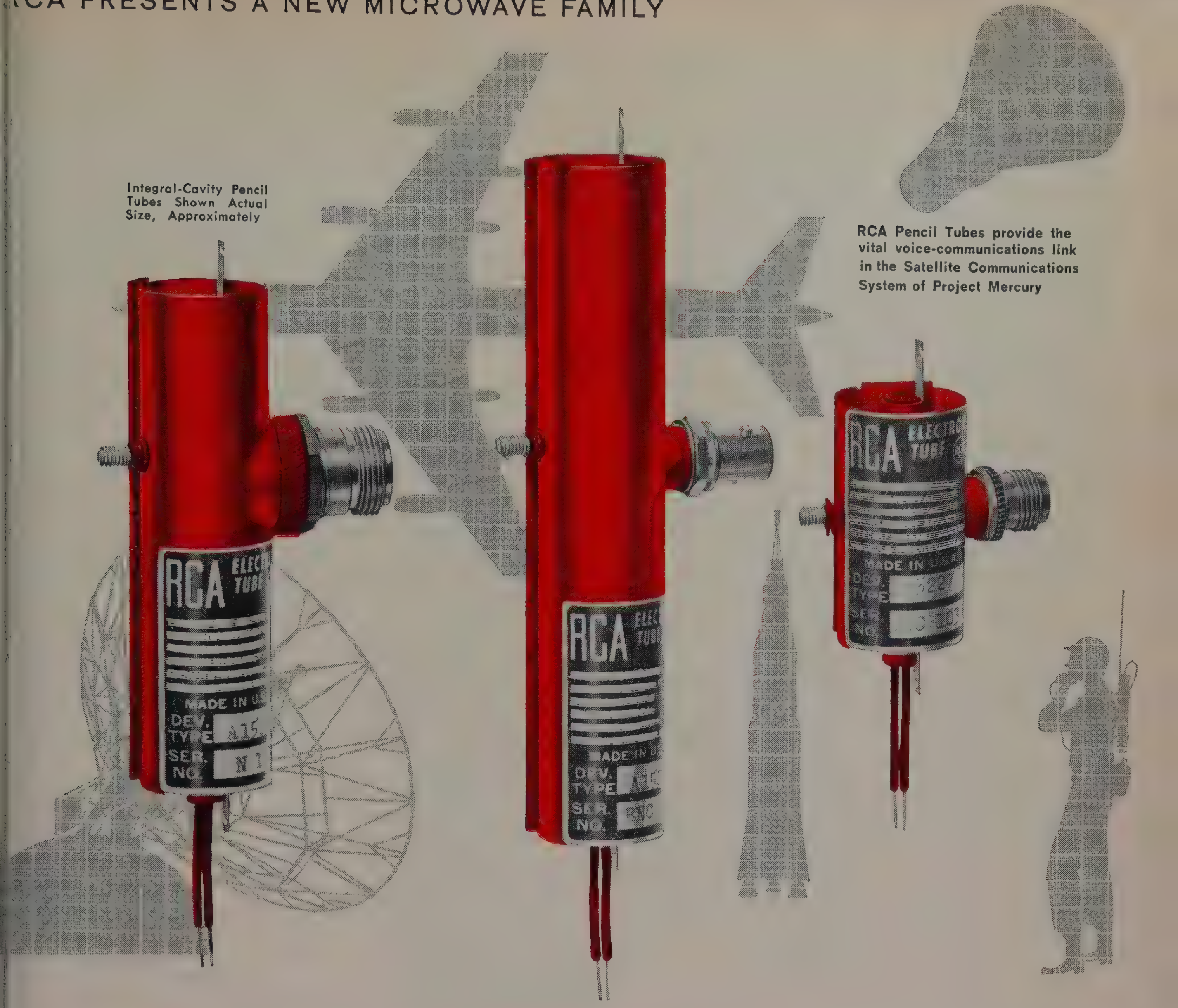
Prior to joining RCA in 1957, Mr. Enders was Chief Development Engineer for Aeronca Manufacturing Company. He also served as a staff engineer at the Massachusetts Institute of Technology.

He received his BS and MS Degrees in Aeronautical Engineering at MIT.

—*mwj*—

(*Continued on page 60*)

RCA PRESENTS A NEW MICROWAVE FAMILY



Integral-Cavity Pencil Tubes Shown Actual Size, Approximately

RCA Pencil Tubes provide the vital voice-communications link in the Satellite Communications System of Project Mercury

Integral-Cavity PENCIL-TUBE OSCILLATORS

- From 900-3400 Mc
- Low-cost
- Includes RF Circuitry
- Compact

OVERALL RF PERFORMANCE ASSURED

ow, RCA offers the recognized performance-dvantages of the famous coaxial pencil tube . . . in a design which combines the pencil ıbe with a mechanically-tuned cavity—to roduce a single-unit, compact, low-cost ıicrowave oscillator.

Wherever circuit compactness and gross eight are major considerations in microwave esigns, RCA Integral-Cavity Pencil Tubes old intrinsic possibilities—for CW, plate-ulse, or cathode-pulse work. There's a choice of over 20 types. And note this: RCA's Applications Engineering group is available to discuss special Integral-Cavity Pencil Tubes "tailored" to your specific requirements.

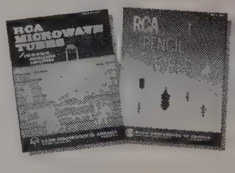
For information on RCA Integral-Cavity Pencil Tubes—and other integral cavity developments such as amplifiers, harmonic generators, voltage-tuned oscillators, get in touch with your RCA Field Representative. Or write: Microwave Marketing, Building 55, RCA Electron Tube Division, Harrison, N.J.

TYPICAL PERFORMANCE OF REPRESENTATIVE OSCILLATORS

RCA-Dev. Type	Power Output (Watts)	Duty Cycle	Freq. (Mc)	Input Pulse Voltage
A-15132	500 (Peak)	0.001	1100	50
A-15228	300 (Peak)	0.001	2000	50
A-15234	100 (Peak)	0.001	3000	50
A-15221	1	CW	1100	—
A-15227	0.3	CW	2000	—
A-15233	0.1	CW	3000	—

Important Technical Data for Microwave Designs

- RCA MICROWAVE TUBES and SOLID-STATE OSCILLATORS and AMPLIFIERS (ICE-180C). 16 pages of characteristics on nearly 100 RCA Microwave Devices. Please request on company letterhead.



- RCA PENCIL TUBES (ICE-219). 28-page book on Pencil Tube theory, application, characteristics curves, operating data. Price 50 cents. Please remit with order.

Send your order to—Section I-101-Q, Commercial Engineering, RCA Electron Tube Division, Harrison, N. J.

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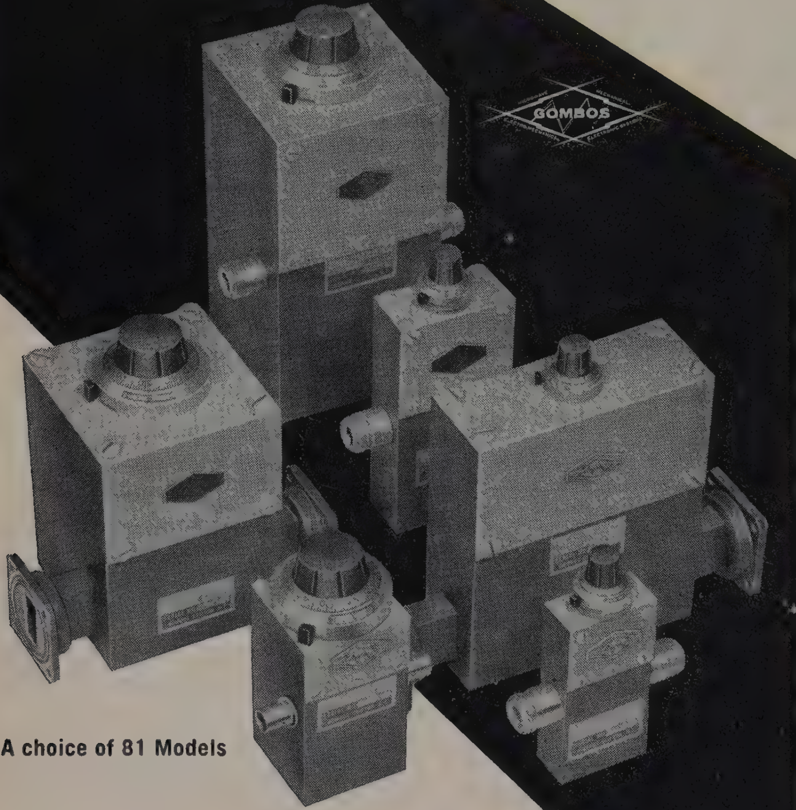
TUNABLE BAND PASS
FILTERS



A choice of 81 Models

A COMPLETE LINE FROM 500MC TO 18,000MC

Single knob tuning
2, 3, & 4 Section models offer a selection of rejection characteristics
Low insertion loss (1.0 D.B. Max.)
Coaxial or waveguide application

The John Gombos Co., Inc. line of TUNABLE MICROWAVE BAND-PASS FILTERS is designed for laboratory application such as Image Filters, Noise Measurements, Harmonic Rejection, Frequency Selection and Spectrum Analysis. These filters are also designed for systems applications such as Video or Superheterodyne Preselection, Resonant Diplexing, Frequency Discrimination, Multiplexing and Band Elimination.

JOHN
GOMBOS
CO., INC.
WEBRO ROAD, CLIFTON, N. J.

WRITE TODAY for literature on the John Gombos Co., Inc. line of Triode Oscillators and Amplifiers, Tunable Band Pass Filters and Front End Assemblies. We would also appreciate receiving your special requirements for active and passive Cavities, Components and Sub-systems.

Circle Reader Service Card 47

Industry News

(*Continued from page 58*)

BLAIR NAMED PRESIDENT OF FXR

Neil M. Blair, president of the RF Products Division of Amphenol-Borg Electronics Corp., Broadview, Ill., ha been named president of Amphenol-Borg's FXR Division.

Henry Feldmann, chairman and president of FXR, Inc., Woodside, N. Y., before it was merged May 31 with Amphenol-Borg, will continue as chairman of the FXR Division, Matthew L. Devine, president of Amphenol-Borg announced. Mr. Feldmann was recently elected to the board of directors of Amphenol-Borg.

Mr. Blair joined Amphenol-Borg in 1959 after serving as vice president and assistant to the president of Intelex Systems, Inc., a subsidiary of ITT.

"Mr. Blair brings to FXR both an excellent technical background in electronics and a record of accomplishment in management and manufacturing," Mr. Devine said.

"We regard microwaves as a fast growing and fast moving technology that will be very important in the future. On a long-range basis, it should eventually replace most of our existing high-frequency communications. Accordingly, we intend to pursue every avenue to develop our FXR Division to the fullest."

—mwj—

GAP FILLER RADAR CONTRACT AWARDED TO BUDD ELECTRONICS

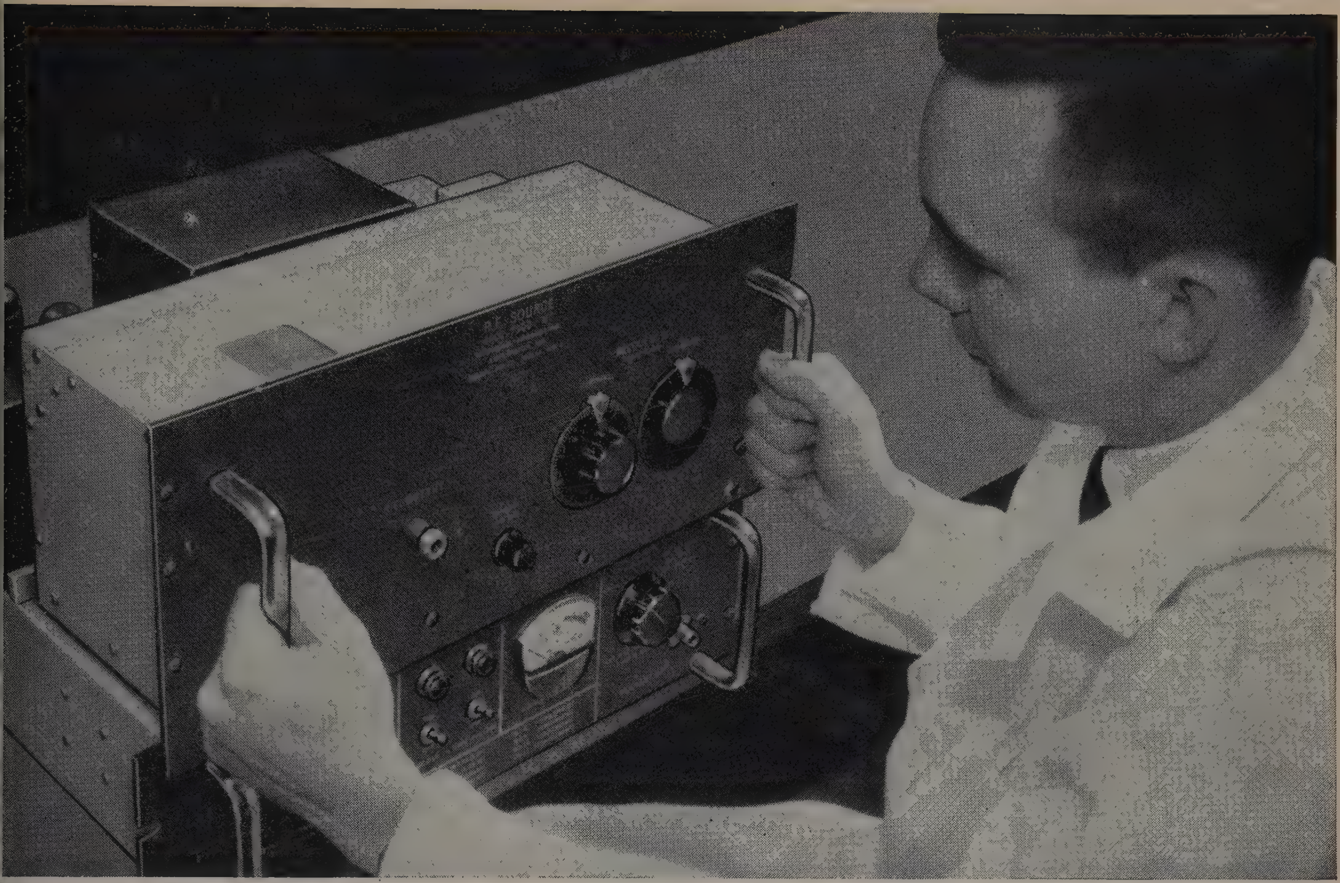
U.S. radar defenses against low flying aircraft will be significantly strengthened as a result of a contract in excess of $3 million awarded to Budd Electronics, Long Island City, N.Y., by the United States Air Force's Rome Air Material Area. The division's president, Robert Young, made this announcement.

Under this contract, a large number of North American Air Defense Command (NORAD) gap filler radars will be modified to improve their operation.

The automatic gap filler radar is part of the SAGE (Semi-Automatic Ground Environment) System. SAGE consists of hundreds of radar stations, automatic computers and data transmitting facilities, and is at the heart of the U.S. Aerial and Electronic Defense. It is used to detect identify and track enemy aircraft, and automatically handles many detailed problems connected with alerting, launching and guiding defense units of aircraft and missiles to their targets.

—mwj—

(*Continued on page 62*)



New Weinschel Plug-in RF Sources for Precision Microwave Measurements provide exceptional amplitude and frequency stability, cover a wide frequency range with true single knob control.

Six new RF Sources, which cover the frequency range of 50 to 10,500 MCS and plug into a common Power Supply-Modulator, have been developed by Weinschel Engineering to meet the demand for stable sources for CW or 100% square-wave modulated RF Power for precise microwave measurements.

For ease of operation, the Power Supply-Modulator, Model MO-3, automatically selects the proper meter range and all the voltages necessary to operate each of the RF Sources without adjustments, thus providing true single knob control. In addition, when a source is plugged into the Power Supply-Modulator, the application of high voltages is automatically delayed until the warm-up of tube filaments is complete.

Klystrons are used above 900 MCS. Castings with integral bearings provide for all moving parts a rigid support which is independent of possible bending of the panel. This rugged construction results in maximum amplitude and frequency stability. The super-honed cavities and non-contacting, low loss, Z-type shorts assure long, reliable and maintenance-free service.

Key Specifications are: *(After 30 minutes' warm-up)*

Stability of output power (both CW or Modulated): Better than 1% in 8 hours (for constant load).

Stability of Frequency of 1000 cps Modulator: Better than .01%.

Frequency Stability: 50 to 920 MCS: better than ± .1%. 900 to 10,500 MCS: Better than 1 part in 10^4 in 8 hours, better than 1 part in 10^5 in 15 minutes.

MODEL NO.	FREQUENCY MCS	FOR 50 OHM LOAD	
		MINIMUM POWER OUTPUT, CW	MINIMUM PEAK POWER OUTPUT (100% Square Wave Modulated)
MS-12	50-250	40 MW	40 MW
MS-13	250-920	100 MW	100 MW
MS-8	900-2200	20 MW	20 MW
MS-9	2100-4200	2100-2600 MCS: 30 MW 2600-4200 MCS: 50 MW	2100-2600 MCS: 30 MW 2600-4200 MCS: 50 MW
MS-10	4000-7300	50 MW	50 MW
MS-11	7200-10,500	7200-7400 MCS: 20 MW 7400-9700 MCS: 50 MW 9700-10,500 MCS: 20 MW	7200-7400 MCS: 20 MW 7400-9700 MCS: 50 MW 9700-10,500 MCS: 20 MW

Write for complete specifications.

WEINSCHEL ENGINEERING®

WE CO

KENSINGTON, MARYLAND Phone: LOckwood 4-0121 TWX Kensington, Maryland 446

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are

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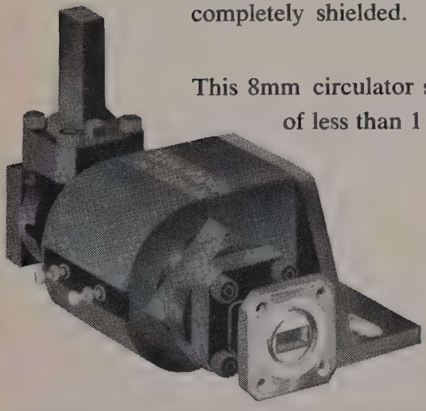
in MILLIMETERS

YET?

WE are, with circulators, isolators, modulators, and switches. In fact, Ferrotec has the most complete line of millimeter ferrite devices in the industry — covering bands to 75 Kmc.

FERROTEC INC
MOD. NO R-297
FREQ. 33.2
SER NO 7
17-027671

This miniature isolator, for example, for 8mm wavelengths, provides 20db isolation for 1db loss over a 6% band, all in $1\frac{1}{32}$" length, 1" diameter, 2 oz. in weight, and completely shielded.



This 8mm circulator switch offers switching times of less than 1 usec, over a 3% bandwidth.

Here are typical standard millimeter ferrite devices, from our line of nearly 50 different stock-design components — quickly available to you!

Type	f_o (Kmc)	Bandwidth	Model
Circulator switch	70	5%	R-227LS
Tee circulator	70	3%	T-153L
Circulator	70	3%	R-224L
Circulator switch	52.5	6%	R-307LS
Circulator switch	35	6%	R-300LS
Isolator	35	6%	R-343L
Circulator switch	33	3%	R-222LS
Circulator switch	24	6%	R-214LS

Ferrotec, specialists in ferrite components, offers the most comprehensive line — from 250 mc to 75 Kmc — in the industry. Do you have the complete catalog?

FERROTEC INC.

217 CALIFORNIA STREET • NEWTON 58, MASS.

Circle Reader Service Card 49

(*Continued from page 60*)

BOEING FORMS NEW ELECTRONIC DESIGN ORGANIZATION

The regrouping of electronics production activities within the Boeing Company Aero-Space Division and the formation a new electronics design organization ha been announced by the company.

Named to the new post of electroni manufacturing manager was R. H. Nelso formerly manufacturing manager for th Boeing Bomarc missile program.

In a separate action, a new electroni packaging group was formed under th acting direction of R. W. Lantz.

The new electronics packaging desig section under Lantz is composed of desig specialists in air-borne and ground-base missile electronics. It will support desig requirements for existing and propose Boeing projects. The new design sectio is expected to grow substantially to accommodate anticipated workloads.

The responsibilities of the new manufacturing manager organization will cu across program lines to include all electronic and electrical manufacturing in th Aero-Space Division. It is estimated tha about one third of the division's productive effort is in this field.

Charles Davis, former unit chief of Bomarc structural assembly, will replace Nelson as Bomarc manufacturing manager.

—*m w j*—

DR. VASSILIADIS JOINS KANE ENGINEERING LABORATORIES

Dr. Arthur Vassiliadis has joined Kan Engineering Laboratories, Palo Alto, Cal as senior electrical engineer according t Kirkwood G. Colvin, president.

Dr. Vassiliadis has been with Stanfor Research Institute in the Electromagneti Sciences Group, concerned with antenn and electromagnetic theory since 1955 His principal effort has been directed towards the broadband matching of antennas, the study of precipitation generated interference in aircraft antennas, and the design of feeds for large radar antennas.

Dr. Vassiliadis received a BS degree in electrical engineering in 1951 from Syracuse University, an MS degree in 1952 and a PhD degree in 1961, both in electrical engineering from Stanford University.

From 1952 to January, 1955, he attended Stanford University. During this period his work was in the field of ionospheric propagation and was particularly concerned with the properties of the Sporadic-E region.

—*m w j*—

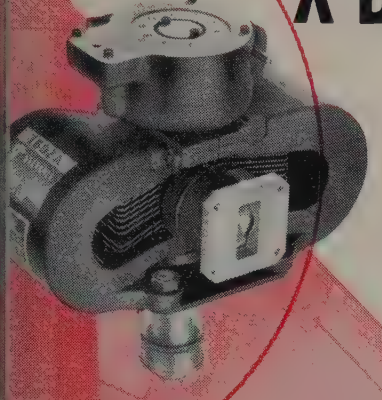
(*Continued on page 64*)

NEW!

Unique tuner design of

X-Band Tunable Magnetron

improves airborne radar performance



Provides: linear tuning; precision tuning; low thermal drift, freedom from vibrational resonance, rugged, reliable structure!

Sylvania-7692A is a highly stable pulsed magnetron offering 220KW peak power output over the 8550 to 9650MC range. It combines a remarkable *new tuner design* with *proven dispenser type cathode* in a rugged package capable of withstanding heavy shock and excessive temperatures. (Tests to date indicate 300°C capabilities.)

Inductive Post Tuner, a Sylvania design, provides linear tuning, simplifying local oscillator tracking, eliminating associated compensating equipment of coupled cavity designs. Features include: a single bellows that tunes all posts simultaneously—secure and precise alignment of tuning posts by means of a guide ring that also serves as an effective heat sink—free tuning post length restricted to 0.200 inches, eliminating electrical and mechanical resonances at very high frequencies—electrically and thermally grounding the tuning posts for very low thermal drift.

Reliable dispenser type cathode, incorporated in Sylvania-7692A, features low heater power requirements, therefore low cathode temperatures, high stability, outstanding life. Cathode memory is of extremely short duration—abrupt switches in pulse length do not detract from cathode performance or life. Too, the molybdenum cathode support is virtually unyielding to vibrational stresses, exhibits very low heat loss, permitting zero heater voltage operation at rated operating current.

Vacuum firing up to 1000°C of individual parts prior to assembly effectively de-gasses elements, contributing to reliability and the exceptional starting stability of approximately 0.05% average missing pulse count.

Additional X-band, tunable types from Sylvania include: 7006, 210KW peak power output; M-4164, 220KW peak power output; 7692, 220KW peak power output. Presently under development are significant refinements to the 7692A, including a hydraulically tuned version.

In short, the intensive magnetron development program underway at Sylvania deserves your close investigation. Contact your Sylvania Sales Engineer for up-to-the-minute information. For tech data on specific types, write Electronic Tubes Division, Sylvania Electric Products Inc., 1100 Main St., Buffalo 9, N. Y.

TYPICAL OPERATION—SYLVANIA-7692A

Duty cycle	0.001	
Pulse width	1.0	µsec
Rate of rise of voltage	200	KV/µsec
Avg. anode voltage	27.5	mAdc
Peak anode voltage	22.0	KV
Avg. power output	220*	W
Pulling factor	12	MC
Pushing factor	0.25	MC/A

*Min. power output—200W

SYLVANIA

SUBSIDIARY OF
GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

For the answers to problems in the design, fabrication, and installation of antenna systems in the fields of scatter communications, missile tracking, space tracking, radar and surveillance, radio astronomy and special antenna products . . .

ASK ASI!

A S I

FOR FULL INFORMATION WRITE: ANTENNA SYSTEMS INC.
HINGHAM, MASSACHUSETTS

Circle Reader Service Card 50

NOW THE FLATTEST COAXIAL ATTENUATOR AVAILABLE

RLC ELECTRONICS INC.

RLC A25
COAXIAL ATTENUATOR

PART NO.	Atten. Value (db)	Variation* (db)	Max. VSWR	Frequency (kmc)
A25-3	3	±0.3	1.3	0.5-11
A25-6	6	±0.4	1.3	1-11
A25-10	10	±0.5	1.35	1-11
A25-20	20	±0.7	1.35	2.11

*Variation of atten. as a function of Frequency.

The most recent advances in resistor film technology insure stability, power handling capabilities and mechanical ruggedness.

Type N Connectors—$32.50 each from stock.
Other Connectors and attenuation values available upon request.

RLC

RLC ELECTRONICS, INC.
805 MAMARONECK AVENUE • MAMARONECK, NEW YORK • OWens 8-3913

Industry News

(*Continued from page 62*)

NAVY AWARDS $8 MILLION CONTRACT TO ITT

An eight million dollar contract to bui high-performance electronic air navig tion equipment for the U.S. Navy's mo modern jet aircraft has been awarded ITT Federal Laboratories, Nutley, N.J.

The award from the Navy's Bureau Weapons calls for the International Te phone and Telegraph Corp. division supply improved TACAN radio se which will provide aircraft with insta taneous, precise bearing and distance i formation.

Displayed on easy-to-read cockpit i struments, a pilot will know his exa position in relation to a selected groun station during every moment of flight.

T. M. Douglas, ITTFL Vice Presiden said the new TACAN equipment is s perior to earlier versions in that it ope ates at higher altitude, at longer rang and is generally more suited for the a vanced capabilities of present and planne aircraft.

Originally developed by ITT to me the pinpoint navigational requirements U.S. Navy carrier-based planes, TACA is now the standard air navigation syste for all military aviation. Under contra to the Federal Aviation Agency, ITT now installing TACAN at selected VO TAC locations for an air navigation pr gram for both military and commerci aircraft.

—mwj—

AIR FORCE CONTRACT RESULTS I BACKWARD-WAVE MAGNETRON

The United States Air Force and Sy vania Electric Products Inc., has announce the recent completion of a research an development contract resulting in the de velopment of a voltage tuneable backward wave magnetron with a tuning range o 10.8 to 15.0 kMc.

Lt. Michael M. Heil, project enginee for the Thermionics Branch of the Ai Force Electronic Technology Laborator at Wright-Patterson Air Force Base, Ohio said the units were sought by the govern ment to extend the frequency coverage o present and future electronic systems Previously available backward-wave mag netrons operate at frequencies up to 1 kMc.

Dr. Rudolph G. E. Hutter, chief engi neer of Sylvania's Microwave Devic Operations, which designed and develope the new units, said that they provide ap proximately 100 watt cw power output i the 10.8 to 15.0 kMc frequency band.

—mwj—

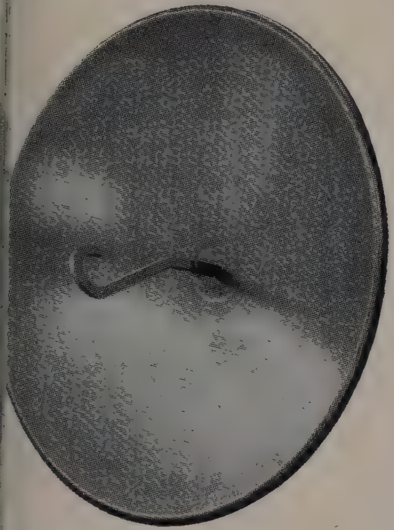
(*Continued on page 68*)

Circle Reader Service Card 51

From An Established Source...TELERAD

Antennas, Waveguide & Coaxial Components

esigned to meet the critical demands of modern R-F ystems, Telerad parabolic antennas and waveguide com-onents offer the utmost in engineering, materials, and aftsmanship. Telerad's test range facilities are in constant use measuring antenna patterns and power gain levels, supplying the most efficient equipment possible...whether it be for established designs, or for highly specialized new radar systems applications. Telerad antennas such as this incorporate a one-piece, spun aluminum reflector, which provides excellent dimensional accuracy while minimizing weight and installation problems.

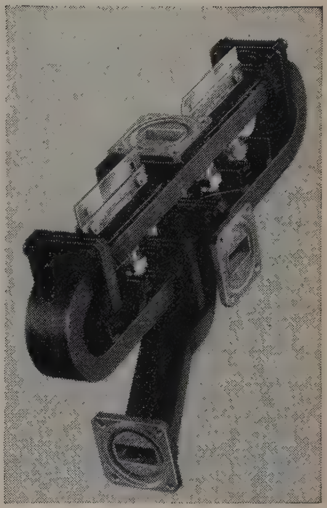


Other features:

- Unique backup structure provides a clean, undistorted reflective area.
- Furnished with a 7° adjustment for both azimuth and elevation.
- Comply with FCC specifications and EIA recommendations.
- Standard antennas cover frequency ranges from 5.9 to 16 KMC.
- Diameters range from 4 to 10 feet.

This is but one type installation; Telerad's capabilities include design and manufacture of many types and sizes for special requirements, such as helical, slotted arrays, dipole and horn antennas.

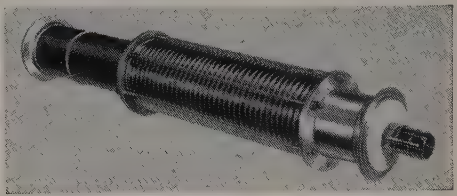
Telerad waveguide is available in four types: • Rigid • Flexible • Twistable • Pre-formed.



Rigid waveguide (Tele-Guide) is supplied in straight sections to 20-foot lengths, meeting all requirements of MIL-W-85C, and constructed of aluminum, brass, silver or magnesium. Choke and cover flanges are fabricated with strict adherence to MIL Specs. Tees, elbows, adapters, pressurized units, directional couplers, cavities, mixers and duplexers, rotary joints and special devices are catalog items. Each Telerad waveguide assembly is thoroughly inspected for end fitting alignment, pressure tightness, and VSWR before shipment.

These components are only a portion of the stock equipment which Telerad offers. In addition, our engineering and production facilities are highly capable of designing or custom-building specialized coaxial equipment for individual installations...

From components to complete microwave or radar systems: Tee Assemblies • Sweep Elbows • Rotary Joints • Flexible Sections • Elbows • Adapters • Reducers • Special Devices • *Plus*—High Power, Lightweight Aluminum Sections for Airborne Application.



We welcome the opportunity to discuss your special antenna, coaxial, and waveguide requirements...from individual components through complete front end assemblies.

◆ Write Dept. 19-Y for new Telerad catalog covering expanded product line.

TELERAD
Route 69-202, Flemington, N.J.

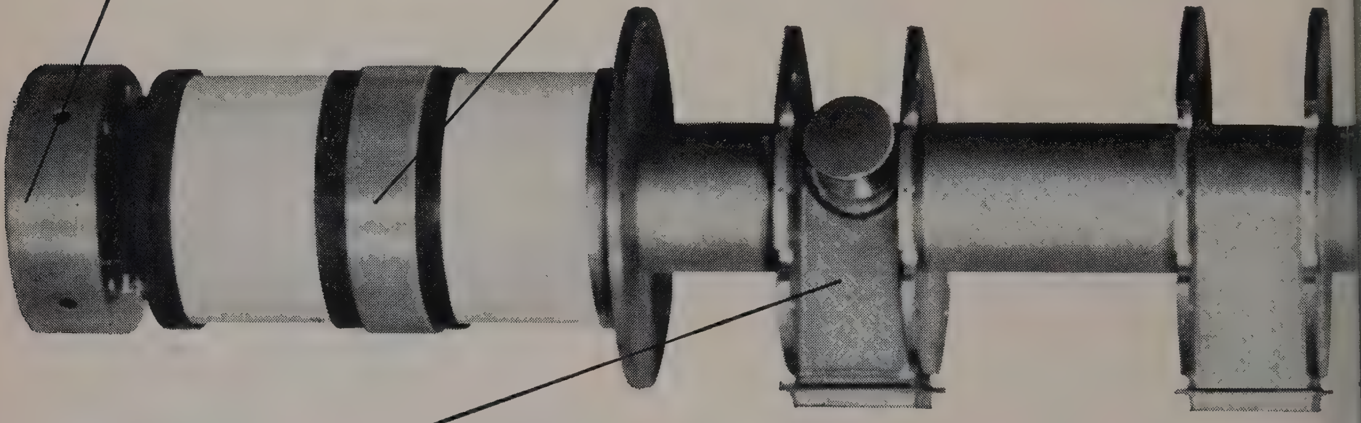
Division of The Lionel Corporation

Circle Reader Service Card 52

HOW TO BUILD THE PERFECT KLYSTRON

1. *Perfect a highly convergent electron gun that will confine electron flow so that your klystron will be stable and have the longest life possible. (Only Eimac has done it—with the Heil gun.)*

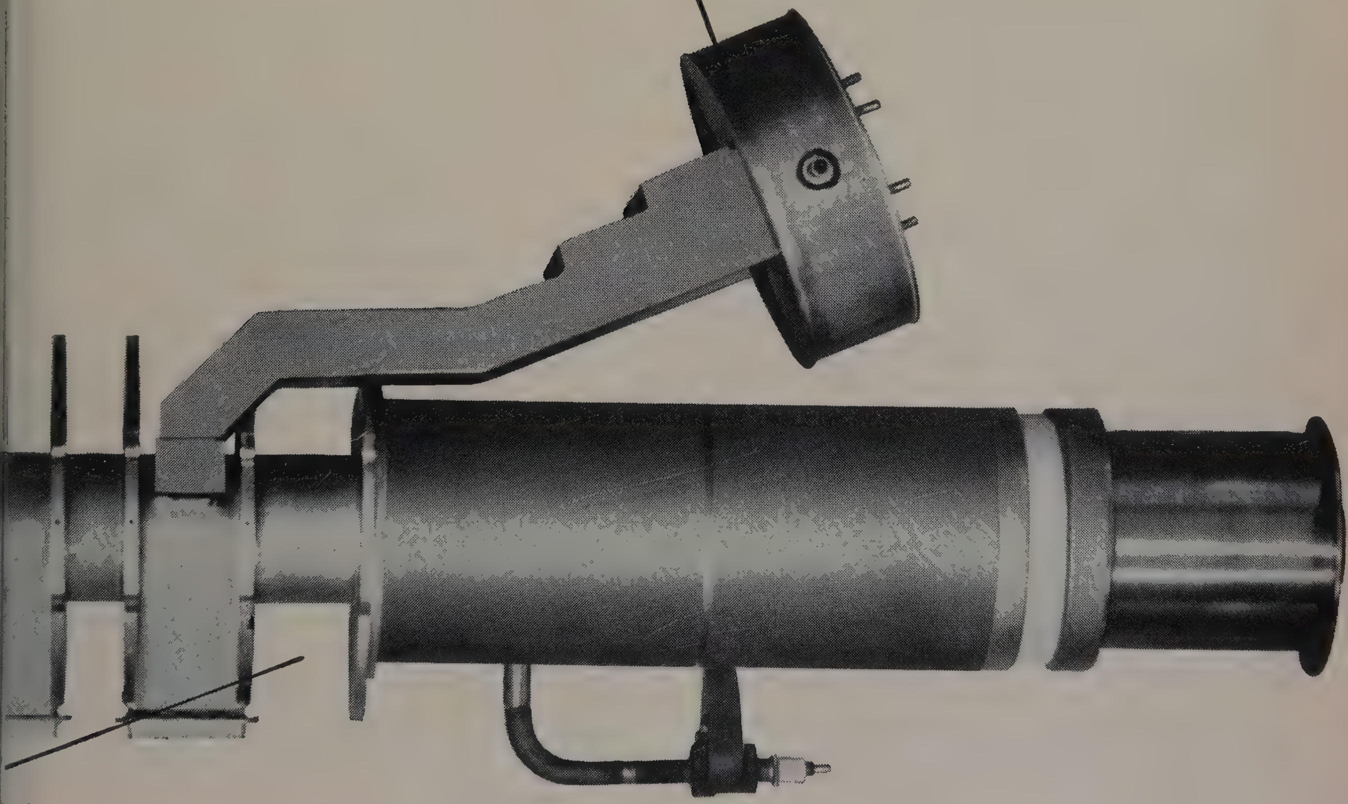
2. *Devise a modulating anode that will slash the power required to precisely control the klystron beam. (Eimac's already done it . . . making super power radar practical.)*



4. *Design your klystron with either an internal, an external, or a combined internal-external cavity to meet* all *power and frequency needs. (Only Eimac is able to do it today.)*

5. *Build and put into successful pulse and CW service more than three thousand high-power klystrons to prove your ideas. (Eimac's already done it . . . with more klystrons than any other manufacturer.)*

3. *Take ten years or more to perfect advanced materials processing techniques including fifty foolproof metal-ceramic seals and the first output windows made with BeO—to give yourself plenty of design freedom. (Eimac's already done it.)*



5. *Do your work in the world's most complete tube development and production facility, one that includes a DC power supply twice as big as any other. (That's Eimac . . . where the new power supply provides 325 KV at ten amps D.C.)*

7. Short Cut: *Just bring your power and frequency needs to Eimac and get your "perfect" klystron fast . . . from the factory* or *the development lab. Test our reaction time by writing or phoning: Power Klystron Marketing, Eitel-McCullough, Inc., San Carlos, California.*

Eimac

Circle Reader Service Card 53

(*Continued from page 64*)

MAIZE APPOINTED TO NEW REMANCO POST

Appointment of James A. Maize to the newly-created post of director, systems applications, for Remanco, Inc., Santa Monica, Cal., manufacturer in the field of dynamic simulation, has been announced by Ronald Ryall, president.

Maize formerly was associated with Hoffman Electronics Corp., Los Angeles, Cal. as supervisor, airborne radar laboratory; TelAutograph Corp., Los Angeles, Cal. as chief development engineer; Hubbell & Miller Company, New York, N. Y. as chief electronics engineer; and was president of U. S. Radio Corporation of San Francisco, Cal.

Maize is a graduate of the University of California at Berkeley where he received a degree in electrical engineering; he is also a member of the Institute of Radio Engineers.

—mwj—

TALLEY INDUSTRIES ANNOUNCES MANAGEMENT CONSOLIDATION

Consolidation of management in its electronics division has been announced by Talley Industries, Inc. (OTC), Phoenix, Ariz., manufacturer of ballistic systems, rockets, solid propellants and electronic equipment.

Effective immediately, Arthur Ehlenberger, Jr., president of Micro-Tech, Inc., Cheshire, Conn., will also assume the presidency of Microwave Dynamics Corp., Plainview, Long Island.

Micro-Tech manufactures microwave transmission equipment and waveguides. Microwave Dynamics manufactures precision microwave components and sub-systems and high voltage test equipment.

—mwj—

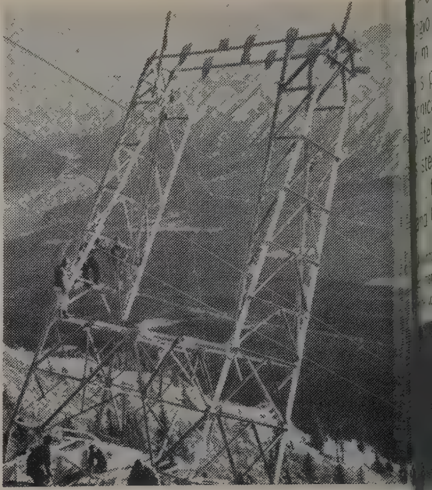
RUSSELL JOINS ADAMS-RUSSELL AS MARKETING DIRECTOR

Earl D. Russell has joined the Adams-Russell Company, Inc., Cambridge, Mass., as Director of Marketing. He will be responsible for sales and advertising in the present product categories of Very High Frequency and Super High Frequency Antennas, RF Microwave Components and RF Electronic Equipment.

Mr. Russell was formerly employed by Sanders Associates, Inc., Nashua, New Hampshire.

—mwj—

MICROWAVE COMMUNICATIONS SYSTEM OPERATES IN WESTERN CANADA



An advanced microwave communications system was officially placed into operation in Western Canada recently b Prime Minister John Diefenbaker c Canada.

Built by RCA Victor Company, Ltd under prime contract to Canadian National Railways, the $25 million system provides improved telephone and telegraph facilities along the Alaska Highway stretching 1,300 miles from Grand Prairi to northwestern Alberta to Mount Dav on the Yukon-Alaska border.

This communications system initiall will be able to provide up to 600 telephone voice channels. Canadian Nationa Telecommunications will operate the new system.

The new system basically consists of 42 microwave stations, located at approximately 5 to 42-mile intervals adjacent to or within distances of up to 15 miles from the Alaska Highway. These stations are made up of buildings, towers, power plants, access roads, aerial-tramways, and all electronic equipment, and are designed for completely automatic, unattended operation.

A special feature of the new facility is an unattended supervisory maintenance communications system. Every station in each of the five major sections of the system is interconnected by a party line voice channel.

Continuous monitoring of all operating facilities at each station is provided in this alarm system. Any failures that may develop in the microwave equipment, power equipment, and building operation (such as high or low temperature, illegal entry, etc.) are reported automatically to the maintenance control center.

—mwj—

HAMRE NAMED MICROWAVE CORP. VICE PRESIDENT

John B. Hamre has been named vice president in charge of sales for Microwave Corporation of America, Stamford, Conn., according to an announcement by Benjamin B. Cravens, president.

(*Continued on page 70*)

HYBRID
ALFORD

Compact RF Hybrids for VHF and UHF

Type 2210

These broad-band transmission-line hybrids have high isolation and low VSWR over very wide frequency ranges and yet are very small even at UHF and VHF frequencies through the use of a symmetrical two-coil balun and two flexible cables instead of rigid transmission line elements. The basic unit is approximately 4 x 4 x 1½" with Type N connectors and the cables are approximately 1/6 wavelength long. This design permits considerable variation in overall dimensions and positions of terminals. Some typical frequency ranges available are:

Catalog No.	Mc Range	Minimum Isolation (db)	Maximum SWR	
			Parallel	Series
2210-50	50-90	55	1.4	1.4
2210-90	90-160	50	1.3	1.45
2210-120	120-240	45	1.4	1.45
2210-200	200-330	45	1.3	1.45
2210-210	210-270	45	1.2	1.3
2210-330	330-550	45	1.3	1.45

AMCI

ALFORD

Manufacturing Company

® 299 ATLANTIC AVE., BOSTON, MASS.

Circle Reader Service Card 54

ew millimeter wave ANTENNAS . . . This is TRG's 3" diameter complete parabolic antenna — the st and only one of its kind. Imagine an antenna this size that has a 4.0 beam width at 70 kmc — resolution mparable to that of a 30" antenna at 7 kmc! Yet, this is now a standard item with TRG, latest addition to e only complete line of millimeter wave band components of all types, covering the entire 26.5 to 140 kmc gion. But we don't want to leave you with the thought that standard components are all you can expect om TRG. On the contrary. Custom r & d work is a specialty of the house. In millimeter antennas alone, TRG s produced custom installations of the following types: lobe switching antennas, monopulse antennas, nical scanning antennas, and circularly polarized antennas. In millimeter systems, TRG has supplied complete 70 kmc microwave assemblies. Whatever your problem — a component, or complete stems development — TRG has more of everything it takes . . . including experience . . to place the answers right in the palm of your hand. Please write for antenna data d Catalog 260A today.

TRG

TECHNICAL RESEARCH GROUP 9 Union Square Somerville Mass

tenna of the future — here and now The new TRG 3" Parabolic Antenna . First of its type ever developed mmercially for millimeter bands. Available in V, E, and F bands. 4.0° beam width at 70 kmc. 22 db maximum e lobe. 32.9 db gain. For millimeter systems and antenna test applications. For specs, see below.

TRG
PUTS
THE FUTURE
IN THE
PALM
OF YOUR
HAND
TRG

TRG ANTENNAS

		A-Band	V-Band	E-Band	F Band	
	Frequency Range — KMC	26.5–40	50–75	60–90	90–140	Remarks
ORN NTENNAS	Gain Standard Horns	A890	V890	E890	F890	Gain — 25 ± .3 db
	Linearly Polarized Feed	A895	V895	E895	F895	VSWR 1.2
	Circularly Polarized Feed	A900	V900	E900	F900*	Axial Ratio: .5 db for 6% band

Solid dielectric lenses

Model No.	Diameter (inches)	Focal Length (inches)
903	3	3
906	6	6
909	9	9
912	12	12

		A-Band	V-Band	E-Band	F-Band	Typical Performance at 4mm:			
	Frequency Range — KMC	26.5–40	50–75	60–90	90–140	Focal Length (inches)	Gain (db above Isotropic)	3 db Beam Width	Max. Side Lobe (db)
OMPLETE ARABOLIC NTENNAS	3 Inch Diameter		V803	E803	F803	1	32.9	3.80°	20
	6 Inch Diameter	A806	V806	E806	F806	2	38.9	1.90°	20
	12 Inch Diameter	A812	V812	E812		4	44.9	0.94°	20
	24 Inch Diameter	A824	V824	E824		8	50.9	0.47°	20
	36 Inch Diameter	A836	V836	E836		12	54.5	0.32°	20

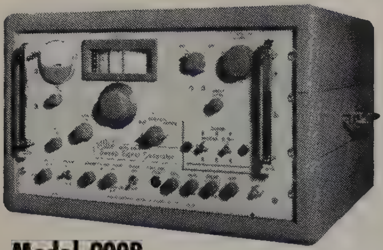
*Under Development

RG INC., ANTENNA & MICROWAVE DEPT., 9 UNION SQUARE, SOMERVILLE, MASS. PHONE: MOnument 6-8680

JERROLD®

SWEEP GENERATORS

NEW!



Model 900B

Very narrow to very wide sweep widths in one sweep SIGNAL generator

$1880.00

Unusual stability in sweep widths from 10 kc to 400 mc. Frequency range 500 kc to 1200 mc. Built-in crystal-controlled harmonic markers, direct coupled scope pre-amplifier, and attenuators. The ultimate instrument for your IF-VHF-UHF requirements.

Model 900A

Wide-band sweep generator

$1260.00

Center frequency: VHF, 0.5 to 400 mc; UHF, 275 to 1000 mc. Sweep widths from 100 kc up to 400 mc. Flatness: ±0.5 db over widest sweep.

Model 707

Ultra-flat sweep generator

$795.00

Featuring ±5/100 db flatness; plug-in oscillator heads*; variable sweep rates from 1/min. to 60/sec.; all electronic sweep fundamental frequencies; sweep width min. of 1% to 120% of C.F.

*Heads available within the spectrum 2 to 265 mc. Narrow-band heads on request.

For applications bulletin and complete catalog (including wide-band comparators, precision attenuators and accessories), write:

JERROLD® ELECTRONICS CORPORATION
Industrial Products Division, Dept. ITE-112
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Export Representative: Rocke International, N. Y. 16, N. Y.

Industry News

(Continued from page 68)

Mr. Hamre was formerly director of sales for Gabriel Electronics and previously, sales manager of General Communications Co. of Boston, Mass.

In his new position, he will be responsible for sales programs, advertising and promotion, and distribution of Microwave Corp. products both here and abroad.

Microwave Corp. of America is a producer of microwave components and remote microwave radar systems used in surveying, weather forecasting and transportation.

—mwj—

AEROSPACE AND NAVIGATIONAL ELECTRONICS CONFERENCE SCHEDULED

The eighth East Coast Conference on Aerospace and Navigational Electronics will be held at the Lord Baltimore Hotel, Baltimore, Md., from October 23-25.

Keynote speaker for the banquet-dinner on October 24 will be General Bernard A. Schriever, Commanding General of the Air Force System Command.

The program is designed to offer scientists in this comparatively infant field an opportunity to hear about and discuss the most advanced ideas in a critical area.

The following 12 major areas will be considered:

On Monday, October 23—Antennas and Propagation, Air Traffic and Navigation, Electronic Systems and Techniques, and Aerospace Communications AJ Techniques (SECRET).

On Tuesday, October 24—Aerospace Command and Control (SECRET), Microwave Components and Microwave Miniaturization, Advanced Aerospace Electronics (SECRET) and Satellite Navigation.

On Wednesday, October 25—Satellite Communication and Control, Real Time Aerospace Data Processing, Radar, and Computers and Data Processing.

—mwj—

NEC MANUFACTURER-REPRESENTATIVE WORKSHOP DATES SET

Answers to the important question "How to Make the Most Effective Use of Representatives" are expected to be reached at the fourth annual Manufacturer-Representative Workshop to be held on Wednesday, October 11th, from 9 AM to 12 Noon, in the Century Room of the La Salle Hotel during the National Electronic Conference (NEC) in Chicago.

Co-sponsored by the Industrial Component and Instrument Divisions of the Electronic Representatives Association (ERA), and the Electronic Sales Managers Association (ESMA), the meeting is expected to bring together approximately 250 technically orientated Representatives and Manufacturers.

The format will follow the panel di cussion and workshop arrangement use in previous years.

—mwj—

ELECTRO-OPTICAL GETS CONTRAC FOR FEASIBILITY STUDY

Electro-Optical Systems, Inc., Pasaden Cal. has received a $24,545 contract fro the National Aeronautics and Space A ministration for a feasibility study of laser beacon for daylight tracking a navigational purposes. Work will be pe formed by the company's Quantum Physics Division.

Electro-Optical Systems is a researc and development organization active i advanced systems and components technology. Company R&D activities cove the broad areas of electrochemistry, electric propulsion, advanced power systems solid state physics, quantum physics, advanced electronics and information systems, and space defense systems.

—mwj—

BOSTON PREPARES FOR NEREM MEETING

The fifteenth Northeast Electronics Research and Engineering Meeting, NEREM 61, will be held in Boston, Mass., November 14, 15 and 16. This meeting has become the third largest of the nation's electronic engineering events, and is sponsored by the Boston, Connecticut and Western Massachusetts Sections of the IRE.

Technical sessions will be held at the Somerset Hotel, and at the Commonwealth Armory. A total of more than 90 papers will be presented in 22 sessions, including panel-workshop day-evening meetings.

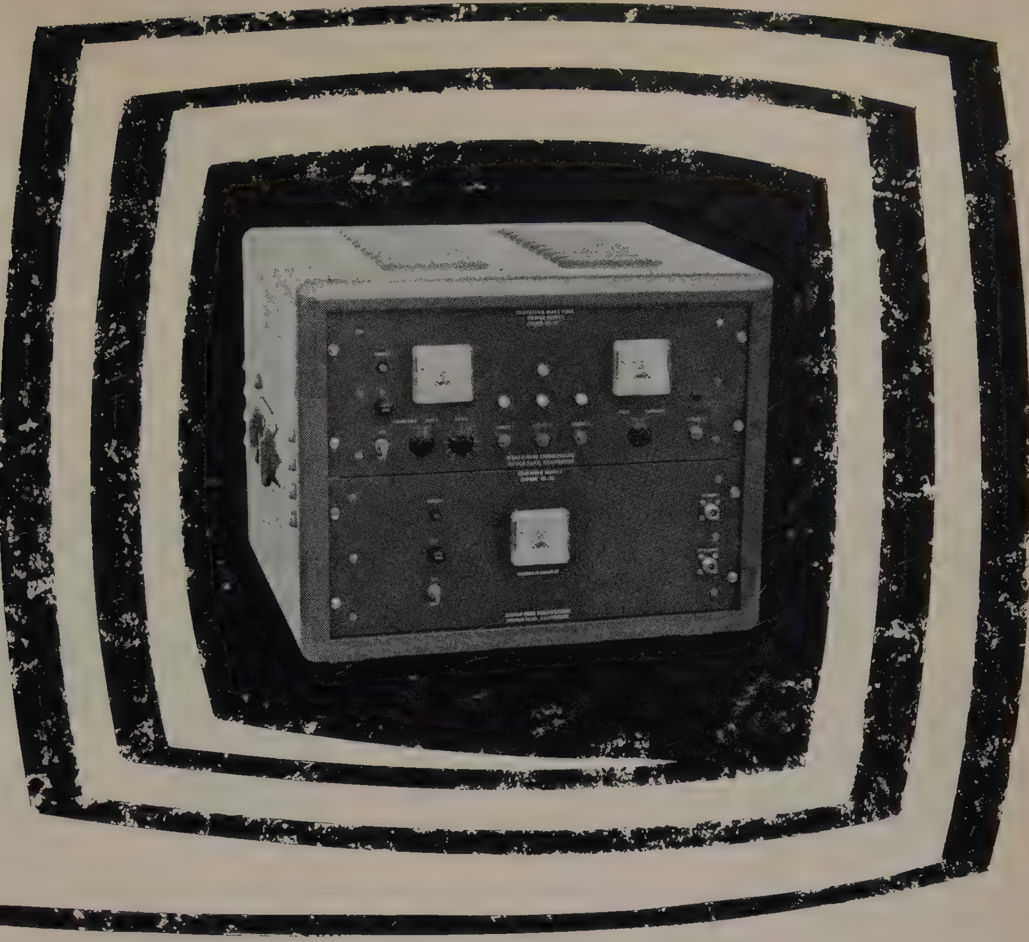
Exhibits will be located at the Commonwealth Armory, where over 400 booths will display millions of dollars worth of electronic equipment.

On Tuesday Nov. 14 at 1:45 p.m. in the Louis XIV Ballroom of the Somerset Hotel after the official opening of the show and introductory remarks by Massachusetts Governor John A. Volpe, John L. Burns, President of the Radio Corporation of America will deliver the keynote address. His topic will be: "New Directions in Electronic Research." Wednesday evening, Nov. 15, at 6:00 p.m., Somerset Hotel, is the time and place of the annual NEREM Banquet. Speaker of the evening will be Professor C. H. Townes, Provost, MIT.

Registration fee for the event is $2.00. All IRE members registering will receive, at no additional charge, a copy of the NEREM Record. Cost of the Record to non-IRE members attending will be $2.00.

In honor of the event, Governor Volpe has issued a Proclamation declaring the week including NEREM as "Electronics Week in Massachusetts."

—mwj—



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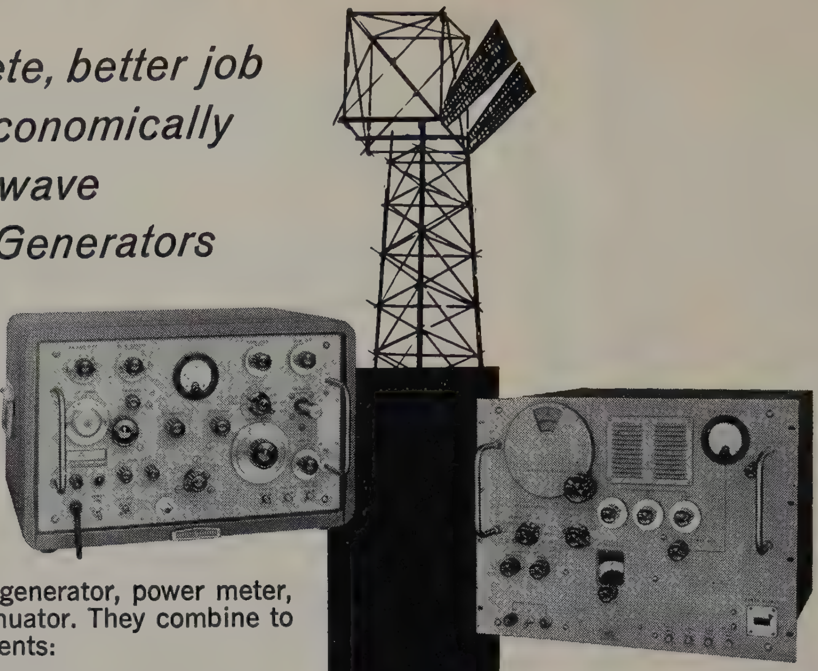

DY-624C X-Band Test Set (left)
DY-5381 High Power X-Band Signal Generator (above)

Dymec Microwave Test Sets and Signal Generators combine several basic instruments in one compact unit to give faster and more economical test and maintenance service for microwave systems.

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DY-624C X-Band Test Set, particularly useful for testing complete radar and fire control systems or radar beacon equipment.

DY-5003 X-Band Test Set, incorporates features of the DY-624C, has higher output power, more accurate attenuator, is protected against accidental application of high input signals.

DY-5381 High Power X-Band Signal Generator, provides minimum output of 250 milliwatts over its entire range, approximately 400 mw at band center; especially useful for testing radar systems through directional couplers. Also useful as parametric pump.

DY-5636 H-Band Test Set, covers the important microwave relay communications band, is particularly convenient for testing complete communications systems.

Brief specifications are presented here. Write your Dymec/Hewlett-Packard representative or contact us directly for complete information.

SPECIFICATIONS	**DY-623B**	**DY-624C**	**DY-5003**	**DY-5381**	**DY-5636**
Frequency Range	5925-7725 mc[1]	8500-10,000 mc	8500-10,000 mc	8500-10,000 mc	7125-8400 mc
Frequency Meter Range	5820-7780 mc	8500-10,000 mc	8500-10,000 mc	—	7125-8400 mc
Output Power	0 dbm (1 mw)	0 dbm (1 mw)	15 dbm (30 mw)	24 dbm (250 mw)	15 dbm (30 mw)
Output Attenuator Range	70 db	100 db	100 db	100 db	100 db
Internal Modulation	FM, 1 kc	Pulse, 35-3500 cps FM, power line frequency	Pulse, 35-3500 cps FM, power line frequency	Pulse, Square Wave, 35-3500 cps. FM, power line freq.	FM, 1 kc
External Modulation	FM, Pulse, Square Wave, 30 cps to 100 kc	FM, Pulse, Square Wave, 35-3500 cps	Pulse, FM, Square Wave, 35-3500 cps	Pulse, FM, Square Wave, 35-3500 cps	FM, Pulse, Square Wave, 30 cps to 100 kc
Power Measurement Range, CW	— 6 to + 3 dbm	— 6 to + 3 dbm	— 6 to + 3 dbm	—	— 6 to + 3 dbm
Price	$1,900.00 (transit case)	$2,265.00 (cabinet) $2,250.00 (rack mtd.)	$3,600.00 (rack mounted)	$4,835.00 (rack mounted)	$4,475.00 (transit case)

[1] 3 Klystrons needed for full range.

Data subject to change without notice. Prices f.o.b. Palo Alto.

DYMEC
A Division of Hewlett-Packard Co.

7018

395 Page Mill Road, Palo Alto, California
Telephone: DAvenport 6-1755 TWX-117-U

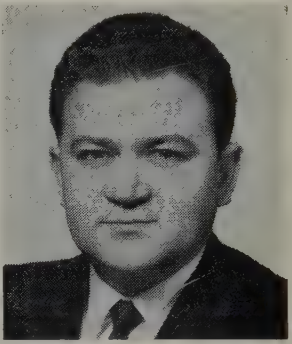
CONTRIBUTORS IN THIS ISSUE

VICTOR J. ALBANESE was born February 2, 1927 in New York, N.Y. He received a B.E.E. degree in 1947 and an M.E.E. degree in 1949 from the Polytechnic Institute of Brooklyn, Brooklyn, N.Y.

From 1947 to 1949, he was a research assistant at the Microwave Research Institute. From 1949 to 1951, he was a member of the antenna group at the Airborne Instruments Laboratory, Mineola, N.Y., where he worked on the development of flush-mounted antennas and associated components for jet aircraft.

He has been associated with the Bogart Manufacturing Corporation, Brooklyn, since 1955, and currently holds the position of Assistant Chief Electronics Engineer and Head of the Special Devices Section.

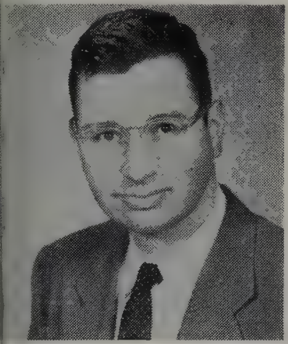
Mr. Albanese is a member of Tau Beta Pi, Eta Kappa Nu, and Sigma Xi.



HERMAN KAGAN received his B.E.E. degree, magna cum laude, at the Polytechnic Institute of Brooklyn, in 1951, and his M.E.E. from that Institute in 1956.

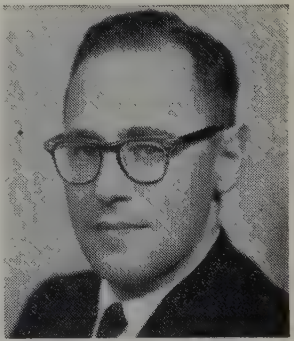
He joined the Bogart Manufacturing Corporation in 1952 and engaged in the design and development of microwave components. In 1956, Mr. Kagan was appointed Chief Electronics Engineer, responsible for all microwave component design and development within the corporation, and in 1958 was appointed to direct all engineering activities at Bogart.

He is a member of the IRE, Eta Kappa Nu, Tau Beta Pi, and Sigma Xi Societies.



JOHN REED was born in Cambridge, Massachusetts, in 1922. He received a B.S. degree in Physics in 1943 at M.I.T. After three years in the RF Components Group at the M.I.T. Radiation Laboratory, he went to Cornell University for graduate study. In 1947 he joined the Submarine Signal Company and the next year transferred to the Raytheon Company where he is now employed on microwave problems.

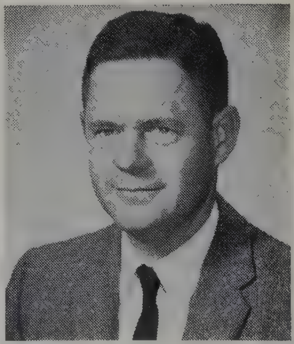
He is a senior member of the IRE, a member of the editorial board of the P G M T T and of the review board of *the microwave journal.*



BRUNO O. WEINSCHEL's education included attendance at the Technische Hochschule, Stuttgart, Germany, Brooklyn Polytechnic Institute, Columbia University, and Georgetown University, Washington, D.C.

A registered Professional Engineer in the District of Columbia as well as in the State of Maryland, Mr. Weinschel was formerly Chief Engineer of the Industrial Instruments Co., and later Consultant to the National Bureau of Standards. He founded Weinschel Engineering Co., Inc., Kensington, Maryland in 1952 and is its President.

Mr. Weinschel is a senior member of the IRE, a member of the American Institute of Electrical Engineers, American Physical Society, American Association of the Advancement of Science, American Ordnance Association and the Electronic and High Frequency Instruments Committee, AIEE.



ROBERT B. WILDS received his BSEE degree from Auburn University in 1950. He was employed by Sandia Corporation from 1950-1955 as a section supervisor. In 1955 he joined Melpar, Inc., as a Senior Microwave Engineer and was engaged in the design of stripline and waveguide filter multicoupler arrays and other microwave components.

Since October, 1956 he has been employed by Sylvania Electronic Defense Laboratories in Mountain View, California. At Sylvania he has been engaged in the design of microwave components for countermeasure systems. Most recently this effort has included work on tunnel-diode microwave circuitry and miniaturization.

Mr. Wilds is a member of Tau Beta Pi, Eta Kappa Nu, IRE and an associate of RESA.

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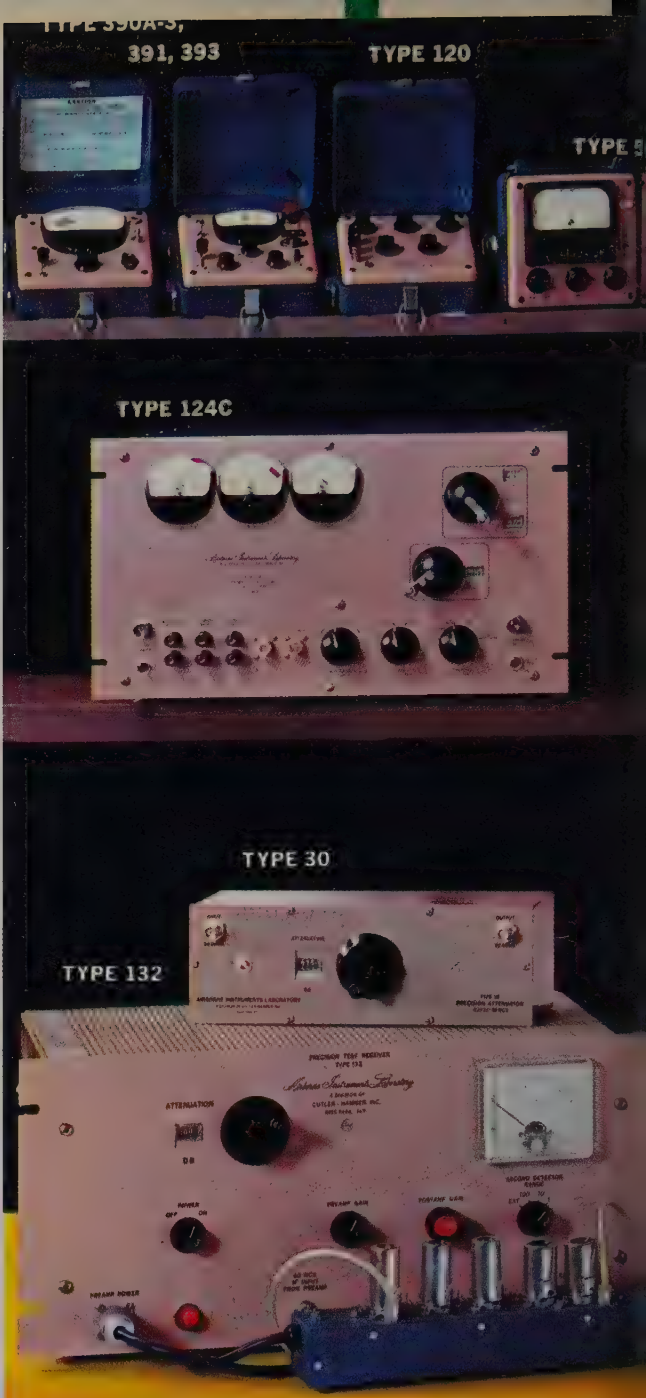

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(including the most and the be in noise figure measurement.)

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TYPE 390A-3, 391, 393—Crystal Test Sets
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Get the highest available accuracy in th piston type attenuator.

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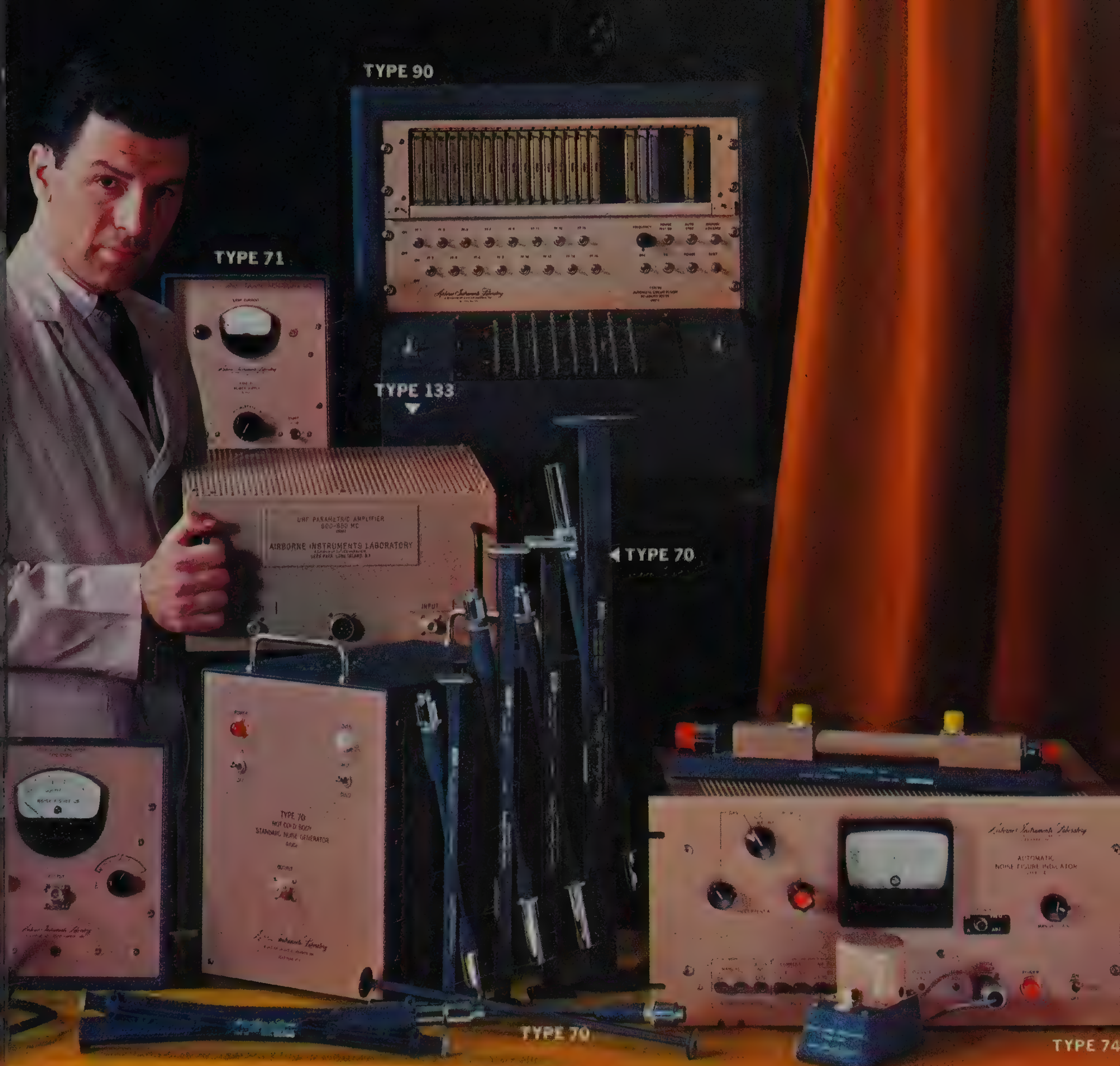
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TYPE 71
TYPE 133
UHF PARAMETRIC AMPLIFIER
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TYPE 70 HOT COLD BODY STANDARD NOISE GENERATOR
AUTOMATIC NOISE FIGURE INDICATOR
TYPE 70
TYPE 74

y tool. Calibrate R-F attenuators and
plers. Measure noise figure and selectivity.

ATURES: Incorporates Type 30 attenuator.
and 60 Mc standard frequencies. Noise
re 1.6 db at 30 Mc; 2.4 db at 60 Mc.
ces $1,350 and $1,400. Circle publication
. 786.

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Models for automatic or manual noise
re measurement.

ATURES: Frequency range from 10 Mc to
Kmc. Relative excess noise temp: 15.3
± 0.25 db. Price $125 to $330.
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charge noise generators when used manu-
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PE 74—Automatic Noise Figure Indicator
dest frequency coverage is yours with this
ipment. Plus maximum flexibility. Ex-
sive tunable I-F amplifier available.

ATURES: R-F range 10 Mc to 40 Kmc with
pe 70 noise generators. I-F range—30, 60
and 40 to 180 Mc. Noise figure ranges—0 to 25 db, ± 0.5 db; 23 to 36 db, ± 1.0 db. Prices $765 and $830. Circle publication No. 789.

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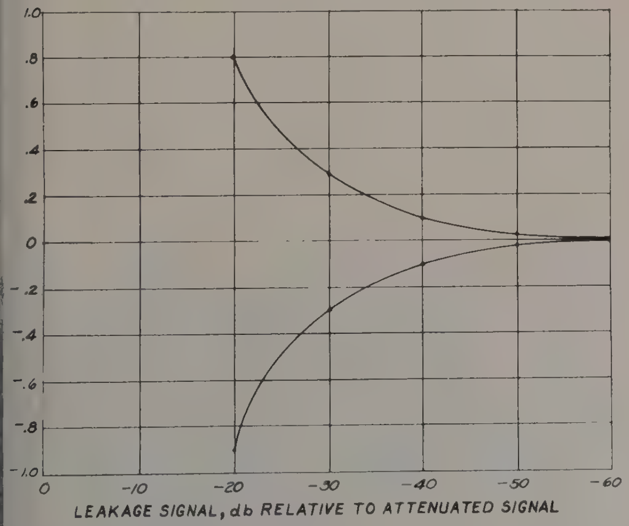
Reflection Loss, Dissipative Loss and Insertion Loss

The attenuation of major interest to an engineer is sually not just the dissipative loss of a device, but the insertion loss" which is a function of both the dissipave loss and the reflection loss at the input and output erminals of the device. Reference 1 defines insertion oss as "the ratio, expressed in db, of the power received t the load before insertion of the apparatus to the power eceived at the load after insertion."

According to this definition, however, one cannot asociate a unique insertion loss with a particular device. he insertion loss will depend on the transmission line, nd the load and source impedance. A second, more estricted definition of insertion loss is sometimes used microwave applications. It requires a source and load atched to the input and output transmission lines conecting to the device. Reference 2 states this restriction s "the specified input and output waveguides connected to the component are reflectionless looking in both directions from the components (match terminated)." This definition results in an insertion loss which is unique for a particular transmission line or transmission lines if input and output lines are not of the same impedance or operate in different modes.



igure 1 — Maximum possible error due to combination of leakage and signal.

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Since the transmission lines in general engineering use are of standardized impedance and components are generally designed for use only in one particular transmission line, it is possible to define the insertion loss of a device with reference to the impedance of its associated transmission line, so that the definition is unique, convenient to measure, and most directly useful. The requirement is merely that the source and load be matched to the impedance of the transmission line. This article deals primarily with the measurement of insertion loss defined in this way, although the techniques and devices described are applicable to the other definitions with only minor modifications.

II. Error Sources Common To All Insertion Loss Measuring Systems

a) Stability, Sensitivity

We shall assume that the amplitude stability of the rf source and of its modulation if required, the stability of amplifiers and the sensitivity of the indicator are such that they do not limit the accuracy or the precision of the measurement.

b) Leakage

It is necessary that undesired signal leakage and crosstalk, magnetic or electric coupling of rf signals and, where applicable, of modulator, i.f., audio and dc signals are reduced to an adequate level. Figure 1 shows the maximum possible effect of rf signal leakage or crosstalk. These maximum errors will occur when the leakage and signal voltages are directly in-phase or out-of-phase. If the leakage is 40 db below the lowest signal level, Figure 1 shows that the error can still be about ±.1 db.

c) Inaccurate Sending and Receiving Impedance

Even if the source and load impedances have been adjusted to an indicated VSWR of 1.00, the true VSWR may differ significantly from 1.00 due to out-of-tolerance connectors or a high residual VSWR of the impedance

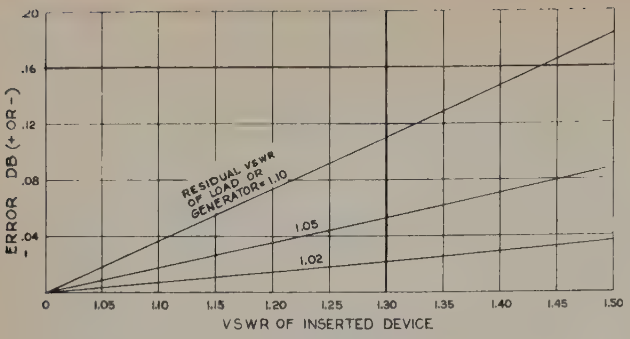

Figure 2 — Maximum possible error due to mismatch of generator or load.

measuring device and associated connectors. This, in combination with a high VSWR of the inserted device, will affect the accuracy although it may not impair the repeatability or precision of the measurement. This is particularly apt to occur in coaxial systems at high frequencies because of the difficulty with coaxial connectors. This error is usually smaller in waveguides than in coaxial transmission lines.

Figure 2 shows the maximum possible error due to these impedance uncertainties. While it is not too probable that this maximum error will occur, a case is on record where the residual VSWR of two slotted lines at a particular frequency in two laboratories was of the opposite phase. In a particular insertion loss measurement this caused a difference in the results at the two laboratories of twice the maximum possible error.

A simplified formula which fits the curves in Figure 2 with an error of about 10 per cent is

$$\text{error} = \pm 4\,(S_1 - 1)\,(S_2 - 1)\ \text{db}$$

S_1 = Error in Source or Load Impedance.
S_2 = VSWR of Inserted Device.

d) Lack of Mechanical Repeatability of Connection

The quality of the coaxial connector or waveguide flange, the mechanical alignment of the inserted device and positive repeatable contacts at the interfering surfaces control the repeatability of transmission line connections. It is assumed that no foreign particles, such as metal chips, peeled-off plating, dust or dirt, oxides, sulfides or other undesirable chemicals are permitted between contacting surfaces or locating surfaces. It is further assumed that the connectors satisfy their mechanical tolerance requirement. Critical dimensions of connectors should be checked periodically by appropriate gauges and indicators to insure that they are not outside their tolerance due to wear or deformation by mating with bad connectors. For precise measurements, rubber gaskets should be removed from the connectors, otherwise the repeatability of a measurement may depend upon the force used by the operator when making the connection. This is illustrated by the gasket in the male "N" connector. The accumulated tolerance build-up may require a minimum compression of 5 mils or a maximum compression of 27 mils of the 1/16 inch thick gasket before the appropriate metal surfaces butt against one another.

Jigs can be designed to insure proper alignment. Reference 3 shows such designs as used at the National Bureau of Standards for insertion of coaxial devices. Figure 3 shows a jig used in production testing at Weinschel Engineering. It allows insertion loss measurements between 4,000 and 11,000 mc in a 50 ohm coaxial system to be made with a repeatability of better than .03 db. However, the type "N" connectors used are of closer than usual tolerances and are made of stainless steel in the product under test and of unplated, hardened alloy steel in the slotted line.

e) Noise

The lowest level at which any system can be used is limited by the system's noise. Noise usually creates two problems. It produces an increase of the average reading of the output meter, and it causes an instability or fluctuation of that reading.

If the detector preceding the output meter is a square law detector, the noise power will cause a certain average reading. If a constant signal power is added to different noise power levels, the increment in the average output due to the signal will not be a function of the noise power level. The sensitivity of linear detectors at low signal levels is much greater than that of square law detectors. Therefore, a linear detector is preferable for such cases. However, for signal levels which are equal to or below the noise level, in a linear detector the noise suppresses the signal so that the increment in output level due to the signal will be smaller the greater the amount of noise present. The converse is also true in linear detectors; if the signal is larger than the noise, the noise contribution to the average output will be suppressed.

The behavior of a linear detector in the presence of noise is of great interest in the region of signal to noise rms voltage ratios of about 10:1 to about 1:1. Figure 4 shows the increase of the average dc voltage output of a linear detector due to noise as a function of the ratio of the rms voltages of signal and noise at the input to the detector. One sees that at a signal to noise ratio of only 7:1, the increase in average output and the systematic error due to noise are less than one per cent. To find the fluctuations in this output, one can use Figure 5 and take account of the bandwidth preceding the detector and the equivalent bandwidth of the output indicator. For example, if the noise originated in a 1 Mc bandwidth, typical of an i.f. system, it is very broadband and as observed on a meter with a time constant of 1/4 second (which is equivalent to a bandwidth of 1 cps), the fluc-

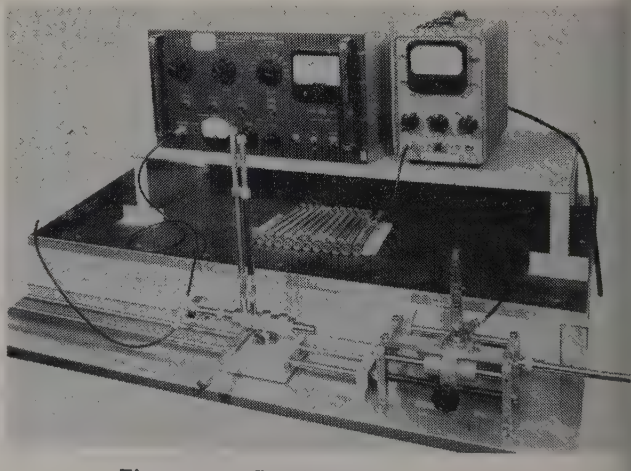

Figure 3 — Bench set-up and test jig.

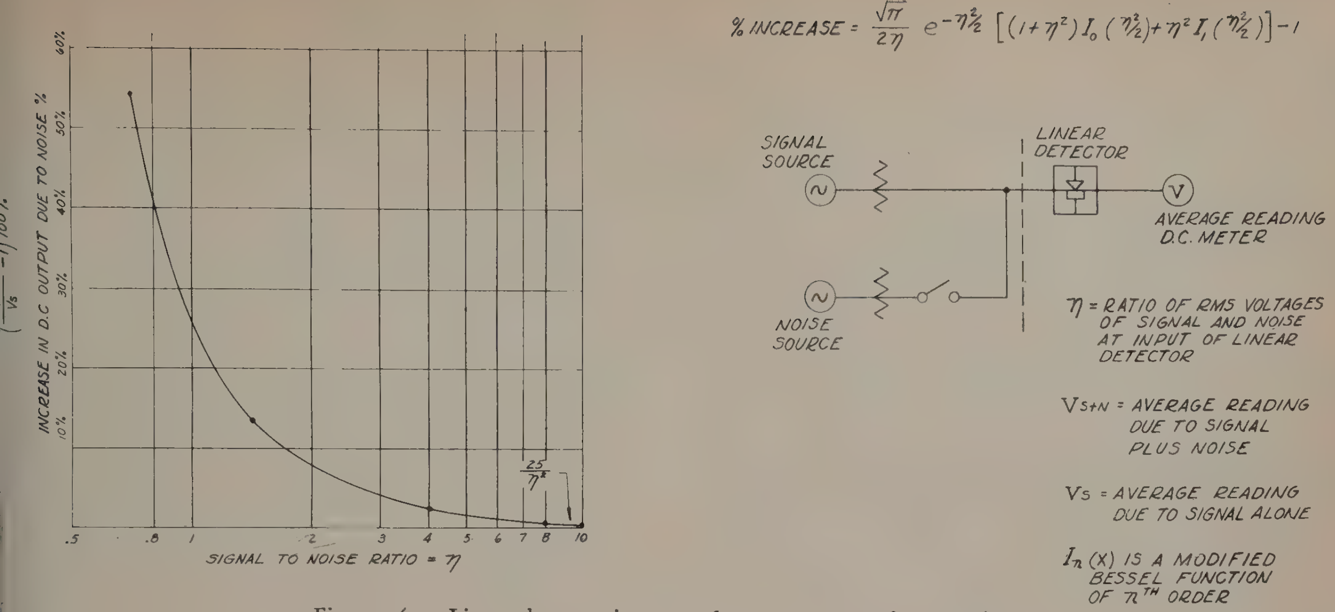

Figure 4 — Linear detector, increase of average output due to noise.

uation will be decreased by the square root of the ratio f these two bandwidths. Thus, Figure 5 shows the rms uctuation for a 7:1 ratio to be about 40 per cent. The mprovement due to the ratio of bandwidths is 1000 and he meter reading will therefore be very stable. However, if this same signal to noise ratio appears in the utput of a 1000 cps amplifier having a passband of 30 ps, the same meter will show an rms fluctuation of almost 10 per cent. To the engineer not familiar with hese mathematical considerations, such a fluctuation may mply that the reading is greatly in error; actually the verage reading is correct within one per cent. It is ecessary, however, to average this fluctuation by eye or mploy a longer time constant. Conversely, one can ommit grave errors with wideband noise. Figure 5 hows that for a 1:1 signal to noise rms voltage ratio, the rms fluctuation is about 70 per cent. An improvement by a factor of 1000 as caused by the same i.f. to meter bandwidth ratio as before produces a very stable meter reading. However, Figure 4 shows that this reading is in error by about 25 per cent. It becomes obvious that one must determine the ratio of the bandwidth of the passband which passes the noise to the equivalent bandwidth of the output indicator. One must also evaluate the ratio of the rms signal voltage to the rms noise voltage. These matters are covered in more detail in References 4, 5 and 6. The considerations are especially important in insertion loss measurements if the signal to noise ratios are different with the attenuator "in" and "out" or if in a two channel or a switched system two signals of different signal to noise ratios are compared with one another.

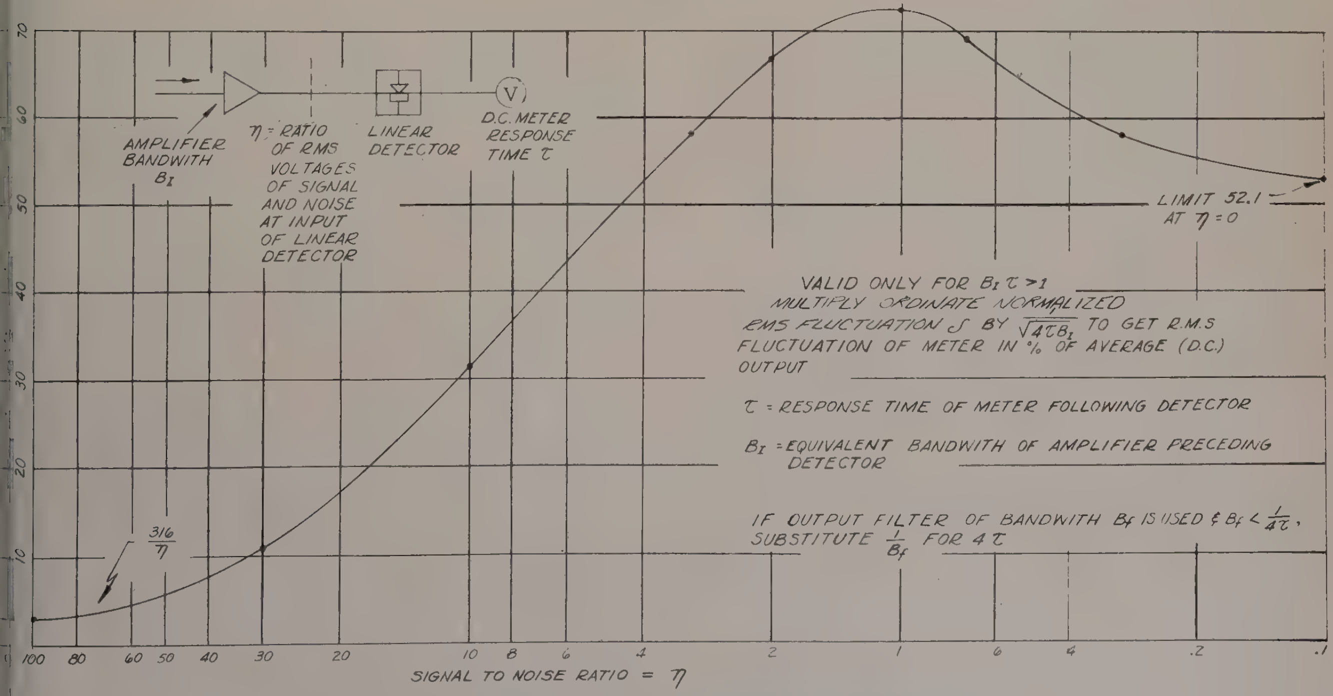

Figure 5 — Fluctuation of linear detector output.

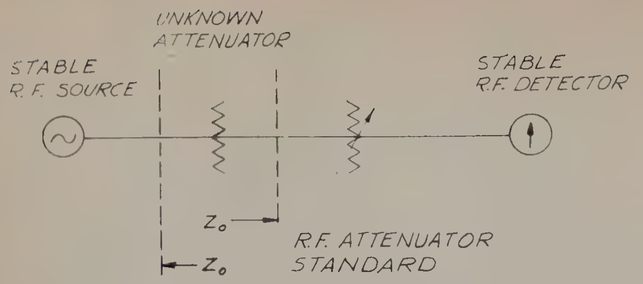

Figure 6 — Measurement of insertion loss by RF substitution.

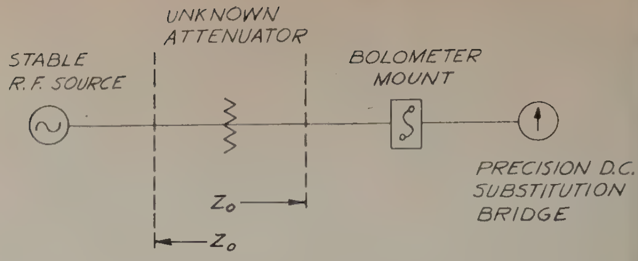

Figure 7 — Measurement of insertion loss by power ratio.

III. Considerations Which Govern the Choice of the Proper Method of Insertion Loss Measurements

In addition to the errors mentioned in Section II, there are usually others which are peculiar to the specific method of making the power ratio measurement. Important considerations in choosing the proper measurement systems are:

1) What is the maximum single step in db one must measure?
2) What maximum rf power level is readily available at the connecting plane having a matched source impedance, and is it compatible with the device under test without changing its characteristics temporarily or permanently?
3) What accuracy and precision are required?
4) Is this a fixed frequency measurement or a sweep-frequency measurement?
5) Is it necessary to change frequency or frequency range often? How difficult is such a change?
6) How much effort is needed for:
   a) Original set-up of system
   b) Change of frequency or frequency range
   c) Periodic maintenance and verification of accurate performance
7) After set-up, how rapidly can satisfactory measurements be performed?
8) What level of skill, experience and special training is required for:
   a) Original set-up
   b) Change of frequency or frequency range
   c) Maintenance and verification of accuracy
   d) Operation

A source of constant incident power is in a sense the electrical equivalent of a matched source. This concept permits one to omit the power consuming isolation pad used with an unmatched source and use instead a high-directivity directional coupler, to supervise the incident power and maintain it constant by manual or automatic feedback. This method is treated in References 9 and 10.

If sufficient rf power is available and can be applied to the device under test without changing its properties, one can usually extend the measurement range beyond the maximum single-step capacity of the system by "partial rf substitution." For example, if +10 dbm is available from a matched source and if the particular method being used has a direct range of 30 db at a maximum level of −10 dbm, one can use a calibrated 20 db rf attenuator to extend the measurement range to 50 db. This is accomplished by measuring the difference in insertion loss between the device under test and the calibrated attenuator instead of measuring the insertion loss of the device directly. It is worth noting that the 20 db attenuator can be calibrated with the same equipment. If this method is used to measure a fixed loss, there is no requirement for a low VSWR of the range extending attenuator since both this attenuator and the unknown will be inserted between the same matched source and matched load. They are never in series. If this "partial" rf substitution is used while calibrating a variable attenuator, the two attenuators will be in series for part of the measurement. Therefore, the range extending attenuator must be matched to the line at its junction with the unknown attenuator. Otherwise, uncertainties will result from the possible range of the reflection loss at that junction. This particular error is treated in References 7 and 8. It is one-half of the error discussed in Section IIc, and must be added to that particular error.

IV. Major Methods of Insertion Loss Measurement

a) RF Substitution

If a good, low VSWR, calibrated variable rf attenuation standard is available, this is a relatively simple method (See Figure 6). The calibrated variable attenuator and the device under test are connected in series. The calibrated attenuator is adjusted to bring the output meter reading to a convenient level, and the attenuator setting is noted. The device under test is then removed and the calibrated attenuator is readjusted to return the output meter to the same level The difference in the two attenuator settings is the insertion loss of the device under test. Depending upon the required range, the receiver can be a simple crystal mount and a VSWR indicator or it may be an rf receiver including a linear mixer. In any case, the receiver is used only to indicate a fixed rf level with and without the device under test. An additional error develops if the rf attenuation standard is not well matched. This causes an uncertainty of

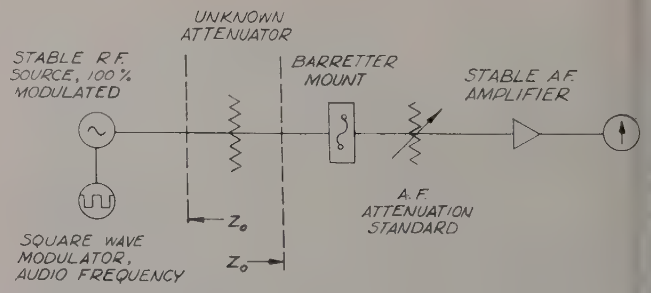
UNKNOWN ATTENUATOR
STABLE R.F. SOURCE, 100 % MODULATED
BARRETTER MOUNT
STABLE A.F. AMPLIFIER
A.F. ATTENUATION STANDARD
SQUARE WAVE MODULATOR, AUDIO FREQUENCY
Z_o
Z_o

Figure 8 — Measurement of insertion loss by audio frequency substitution using square law detector.

the reflection loss at the junction of the unknown and the standard attenuator similar to that discussed under partial rf substitution in Section III.

b) Power Ratio

This method consists of simply measuring the rf power in a power meter with and without the insertion loss element in the circuit (See Figure 7). While it is simple in conception, it is complex in accurate execution. Reference 11 is an excellent example of its capability. As long as the percentage error in the absolute power measurement is not a function of level, this method allows absolute insertion loss measurements directly traceable to dc resistance standards. With good commercial equipment and proper attention to details, a 10 db fixed attenuator pad in X-band waveguide has been measured in our laboratory to an accuracy of .01 db and a precision (or repeatability) of .002 db.

For accurate measurements using bolometer mounts, the bolometer bridge should be one in which both the bias and the substituted power preferably are dc (See Reference 12).

c) AF Substitution

This method is illustrated in Figure 8. It is similar to the rf substitution method, in that the unknown is measured with the help of a calibrated variable attenuation standard. The measurement procedure is similar, but the attenuation standard operates at an audio frequency instead of rf. This is accomplished by using modulated rf which first traverses the device under test and is then demodulated in a barretter or crystal mount, operating as a square law detector, before it goes through the audio attenuation standard to the output level indicator. The obvious advantage of this method is that accurate audio attenuators can be more easily obtained than similar rf attenuators, and their performance is independent of the rf frequency.

The output voltage of a square law detector is linearly related to the input rf power which means that, e.g., a 10 db rf change causes a 20 db audio change. In practice, the large change of audio signal limits the rf range to 30 or 40 db. However, at low rf power levels the square law characteristics of barretters and crystals are remarkably accurate becoming better as the rf power level decreases.

The rf power is preferably 100 per cent square wave modulated at an audio frequency e.g., 1000 cps. A crystal diode rectifying this modulated rf produces directly an audio voltage. A barretter receiving this modulated rf changes its resistance at the audio rate; by connecting this modulated resistor to a source of constant direct current, this resistance variation is translated into an audio voltage. In either case the audio voltage is coupled through the attenuation standard to the output level indicator. A typical 4 milliwatt barretter produces about 3 millivolts rms of the 1000 cps fundamental into a high impedance af load if subject to a 1000 cps 100 per cent square wave modulated rf signal of 200 microwatts peak power. A suitably mounted crystal will produce this level of output voltage with only 2 microwatts of rf power up to 4,000 mc in coaxial transmission lines.

Barretters are accurate square law detectors, i.e., the audio output voltage is very nearly proportional to the rf input power, making them quite popular for use in this application. A measurement of 30 db with an accuracy of ±0.1 db is relatively easy. Silicon crystals used in coaxial mounts at frequencies below about 4,000 mc have a sensitivity about 20 db greater than barretters but are noisier, are more difficult to match to the transmission line and are not as stable as barretters. Details of barretter operation are discussed in References 13 and 14 and the deviation of barretters and crystal diodes from square law is covered in Reference 15.

d) I.F. Substitution

In a heterodyne detector, the output voltage of the mixer at the intermediate frequency is proportional to the rf voltage at the mixer input as long as the local oscillator level is several times greater than the maximum rf level. This "linear detection" of heterodyne signals was treated in 1930 by F. E. Terman (Reference 16).

Figure 9 shows the block diagram of a series type i.f. substitution insertion loss measurement. The measurement procedure is similar to that used in rf and audio substitution. The linear detector allows a direct comparison between rf changes and i.f. changes expressed in decibels. The i.f. calibrated attenuator can be resistive like that used in audio frequency substitution, however resistive attenuators do not have the stability and ease of adjustment of piston attenuators which operate on the waveguide below cutoff principle. The accuracy of piston attenuators depends only upon accurate mechanical displacement. Harnett and Case of Hazeltine Corpora-

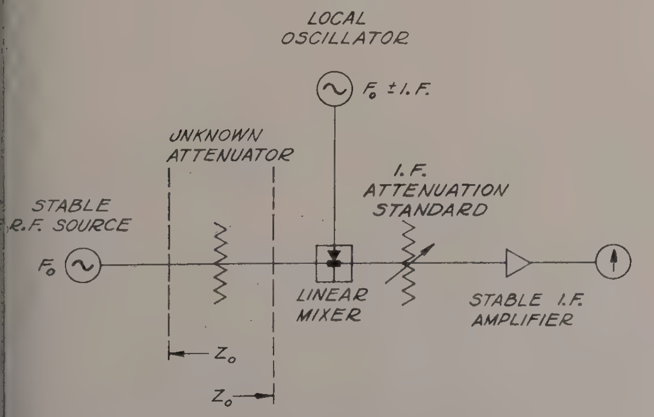

Figure 9 — Measurement of insertion loss by series I.F. substitution using linear mixer.

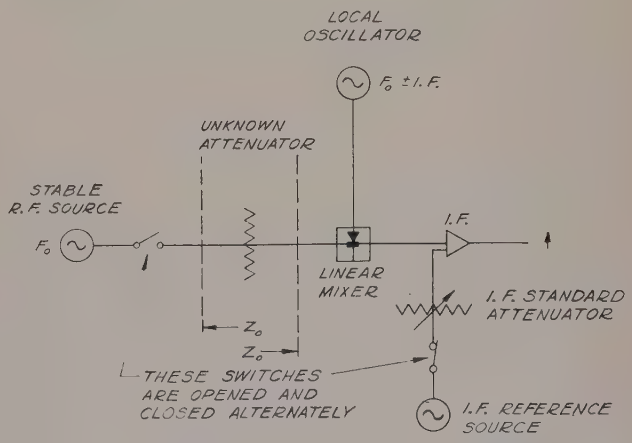

Figure 10 — Measurement of insertion loss by parallel I.F. substitution using linear mixer.

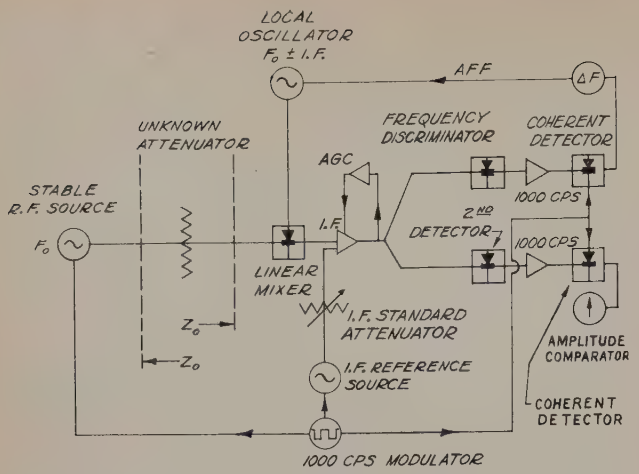

Figure 11 — Weinschel parallel I.F. substitution system.

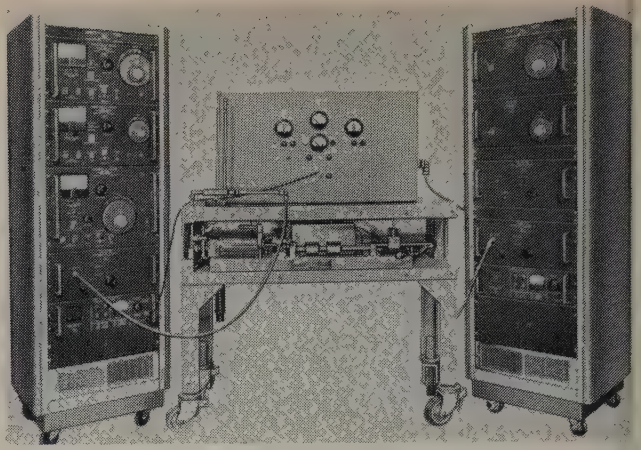

Figure 12 — Model VM-1B with two racks of Sources.

tion (Reference 17) used a piston attenuator in testing of receivers as early as 1935, and they are still used as standards in the most accurate i.f. substitution test sets.

A piston attenuator usually has a minimum insertion loss of 20 to 30 db. Since this minimum loss in a series i.f. substitution test set is between the mixer output and the second detector, it reduces the range, which is limited at the high end by the linearity of the mixer and at the low end by the effect of the system's noise in the detector. This limitation was overcome in 1947 by Gainsborough of the National Physical Laboratory in England (Reference 18) in his parallel i.f. substitution test set shown in figure 10. This test set is operated as follows. The i.f. standard attenuator is adjusted so that the two signals connected to the i.f. amplifier are equal, as evidenced by the fact that there is no output meter movement when one of the switches shown is opened and the other closed. The standard attenuator setting is recorded. Next the process is repeated with the the unknown attenuator removed from the circuit. The difference in the two settings of the standard attenuator is the unknown insertion loss.

Gainsborough's method has two obvious advantages. First, the i.f. amplifier and second detector are only used to compare the mixer output and the reference output. If the switching between these two signals is rapid, instability of the i.f. amplifier gain causes no error; it changes the sensitivity of comparison only. Second, because the standard i.f. attenuator is not in the signal path, the range is not reduced by the 20-30 db minimum loss of this attenuator.

V. Weinschel Parallel I.F. Substitution Test Set Including AGC and AFF*

The block diagram is shown in figure 11. The method of operation is similar to that of the Gainsborough parallel i.f. test set. However, for ease of operation, the switching of the mixer output and the output of the reference source is done automatically at a 1000 cps rate, preferably by square wave modulating the stable rf source and the i.f. reference source in counterphase. The amplitude comparator reads the 1000 cycle component in the i.f. amplifier output envelope. This 1000 cycle component is equivalent to the change in output meter reading when the switches are operated in the Gainsborough test set, and it must be brought to zero before the attenuator setting is read. Since the amplitude comparator should have a fairly constant sensitivity to unbalance over a wide range of signal amplitudes, an AGC circuit is used to regulate the gain of the i.f. amplifier. This results in nearly constant sensitivity to a fixed per cent difference between the mixer and standard attenuator outputs over a range of rf input of −15 dbm to about −90 dbm. A typical sensitivity is .005 db/division at the output indicator.

It is of course necessary that the i.f. signals, which come alternately from the mixer and the reference source, are subject to the same gain in the i.f. amplifier. While the frequency response of the i.f. amplifier is relatively flat, it is best to keep both signals at practically the same frequency in the center of the flat portion of the pass band. An AFF circuit changes the local oscillator frequency automatically to track frequency variations of the rf source. Thus, the mixer output is kept within 5 kc of the 30 mc crystal controlled reference signal even at rf levels as low as −121 dbm. This circuit can track a 1/2 per cent frequency drift of the rf source. When working at frequencies above 1000 mc, this automatic frequency tracking reduces the measurement time considerably and produces a precision similar to that available at 100 to 400 mc.

By using a coherent detector as the third detector the range is extended by about 20 db beyond what it would be with a linear or square law detector, because no systematic error is generated by noise in such a detector. The effect of the integrating time of the meter time constant (about 1/10 second) narrows the effective noise bandwidth of the system without having to narrow down the i.f. bandwidth of about one megacycle. Although there is no systematic noise error, the residual noise determines the lower limit of the instrument's range by generating fluctuation and uncertainty in the output indication. This uncertainty causes a .2 db error at −121 dbm. The upper limit of the range is determined by deviation from linearity in the mixer. The deviation .1 db exists at —15 dbm

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* *Patent Pending*

The maximum single step direct measurement without correction for mixer non-linearity is therefore about 106 db. The accuracy of the piston attenuator which operates at 30 mc is about 0.01 db over its central 70 db portion and over the 60 db range between −30 dbm and −90 dbm, the system's accuracy approaches the accuracy of the piston attenuator.

The test set is treated in detail in References 19 and 20. Figure 12 is a picture of a complete working system including signal sources, local oscillators and mixers covering the frequency range of 100 to 4,000 mc. This system works well in coax to 10,000 mc and in X-band waveguide from 8,200 to 12,400 mc at the present time. It is direct reading, requires no calibration charts, and produces accurate measurements rapidly. After set-up at a particular frequency, the typical test time for calibrating seven 10 db steps of the output attenuator of a signal generator is about 3 minutes. Work is progressing satisfactorily to extend the frequency range of this system to 40,000 mc.

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MICROWAVE TWO-PHASE CONVERTERS FOR IMAGELESS RECEIVERS

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I. Introduction

One of the most serious of the spurious responses present in the output of a superheterodyne receiver is due to the image signal. The image may be defined as a signal whose frequency differs from that of the local oscillator by an amount equal to the intermediate frequency, but whose frequency appears on the opposite side of the local oscillator from the desired signal.

In a conventional mixer, the desired beat frequency results from the quadratic term in the power series expansion of the mixer characteristics:

$$i = A_0 + A_1 e + A_2 e^2 + A_3 e^3 + \ldots$$

Substituting $e = E_o \cos\omega_o t + E_s \cos\omega_s t$, where these are the local oscillator and the signal inputs respectively, it can be shown that the resulting internally generated signals are

$$e^2 = \frac{E_o^2 + E_s^2}{2} + \frac{E_o^2}{2}\cos 2\,\omega_o t + \frac{E_s^2}{2}\cos 2\omega_s t + E_o E_s \cos(\omega_o + \omega_s)t + E_o E_s \cos(\omega_o - \omega_s)t.$$

The term of interest is $E_o E_s \cos(\omega_o - \omega_s)t$. Since frequency has no sign, it is readily seen that for an incoming frequency, ω_s, two values of ω_o, will provide equal outputs at the intermediate frequency. Conversely, for a given setting of ω_o, two values of input signal, ω_s, will provide equal outputs at the intermediate frequency, Therefore, receivers based on the superheterodyne principle have image responses which equal the desired responses in amplitude and number unless circuitry is included for image elimination.

Image elimination is desirable; it reduces interference in a high signal density environment and halves the number of responses visible on a broadband panoramic display. Receivers using TWT preamplifiers also benefit from image suppression due to the suppression of the image noise band. In mechanically-tuned receivers, image effects can be effectively removed by appropriate tuned cavity preselectors inserted between the antenna and the mixer. Such cavities, however, cannot be tuned rapidly enough to be compatible with the frequency sweep rates afforded by the newer voltage-tuned receivers.

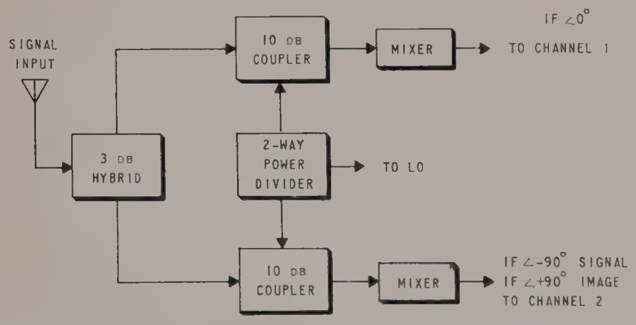

Figure 1 — Two-phase converter, block diagram.

Image rejection in voltage-tuned receivers can be accomplished in several ways, such as:

(a) Backward-wave amplifier tube utilized as a voltage-tuned preselector
(b) Ferrite-tuned attenuator or filter
(c) High intermediate frequency system
(d) Outphasing techniques.

The backward-wave amplifier preselector and the ferrite-tuned devices require auxiliary power supplies and must be synchronously tuned with the sweeping local oscillator. The use of a high intermediate frequency, on the other hand, causes second-order mixer responses which lead to ambiguities in the received signal. These second-order responses result from lower difference frequencies which are harmonically related to the intermediate frequency. Higher-order responses result when harmonics of these difference frequencies fall within the IF passband. Another disadvantage of using higher intermediate frequencies is that, in general, the noise figure of an IF amplifier increases with increasing frequency.

An image suppression scheme based on the outphasing principle and consisting of a two-phase converter and special dual-channel IF circuitry is described herein. The circuits to be described are a continuation of earlier work reported in a paper presented at WESCON in August 1958[1]. The WESCON paper reported results with an earlier circuit and made recommendations for future work. The recommended circuit was subsequently designed, fabricated and tested.

The microwave portion of the outphasing system is called a two-phase converter (or demodulator), because it is designed to provide two equal-amplitude IF signals which are in phase quadrature. This quadrature phase relationship is reversed for image signals. Special circuitry furnishes a differential 90-degree phase shift in one of the two IF channels. This additional 90-degree phase shift at IF allows in-phase addition of the two channels for desired signals and 180-degree phase cancellation for image signals.

II. Discussion

For the outphasing scheme to be practical for use with voltage-tuned local oscillators, a broadband two-phase

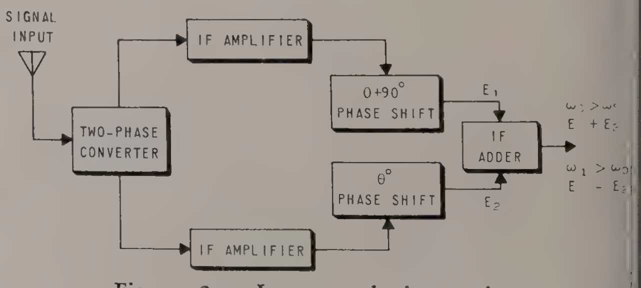

Figure 2 — Image outphasing receiver.

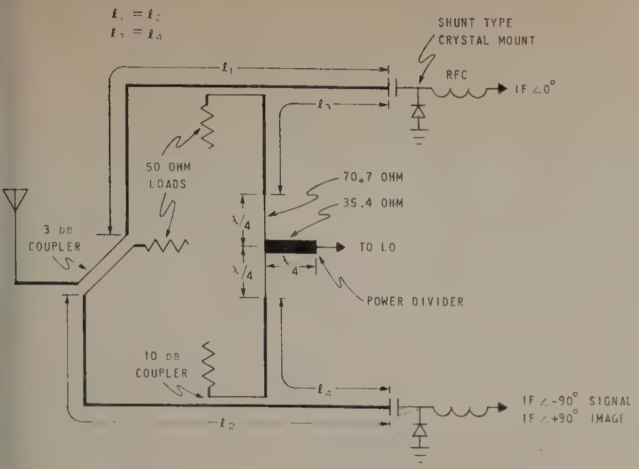
ℓ1 = ℓ2
ℓ3 = ℓ4
SHUNT TYPE
CRYSTAL MOUNT
ℓ1
RFC
IF ∠0°
ℓ3
50 OHM
LOADS
70.7 OHM
35.4 OHM
3 DB
COUPLER
λ/4
λ/4
λ/4
TO LO
POWER DIVIDER
10 DB
COUPLER
ℓ4
ℓ2
IF ∠-90° SIGNAL
IF ∠+90° IMAGE

Figure 3 — Split block coaxial circuit.

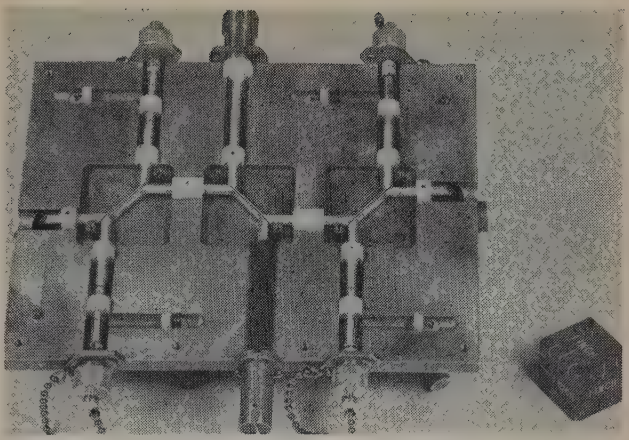

Figure 4 — Open face photograph of balanced mixed two-phase converter.

converter which provides quasi-equal amplitude, quadrature phase IF signals must be used. Figure 1 is a block diagram of the circuit that was used.

The local oscillator signal is fed into a two-way reactive power divider for equal amplitude, equal-phase split. The 10-db couplers are for LO injection to the mixers, and the separate local oscillator signal components arrive at the mixers in the same phase.

The signal from the antenna is fed into the 3-db hybrid where it is split into equal-amplitude, quadrature-phase components. After splitting, the signal components arrive at the separate mixers 90 degrees out of phase, and, because of the analog conversion property of the mixers, this phase difference is maintained in the mixers' IF output.

When the incoming signal frequency is *lower* than the local oscillator frequency (desired signal case), Channel 2 output lags Channel 1 by 90 degrees. Where the incoming signal frequency is higher than the local oscillator frequency (image case), Channel 2 output *leads* Channel 1 output by 90 degrees.

After passing through IF differential 90-degree phase

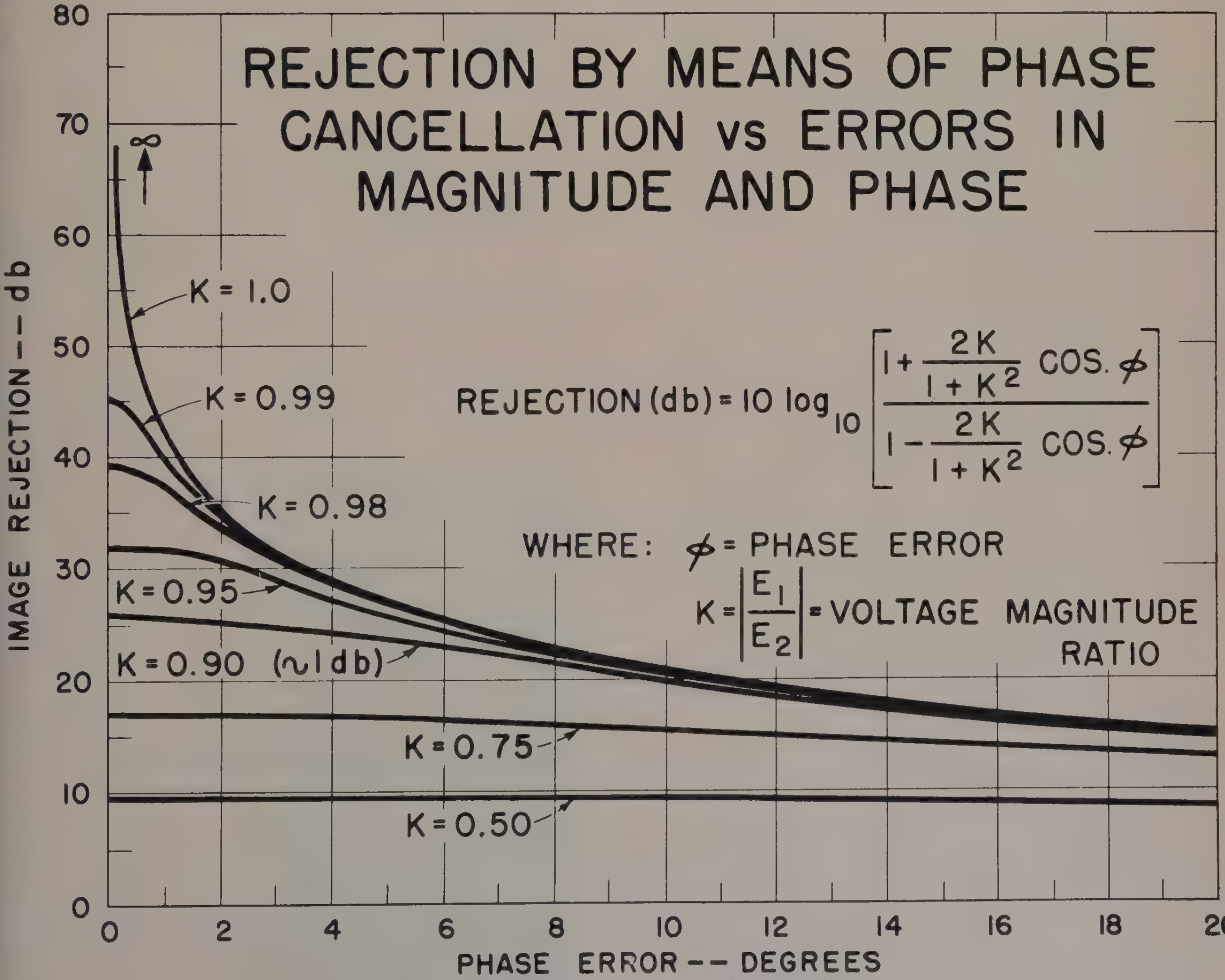

Figure 5 — Image system vs. phase and amplitude errors.

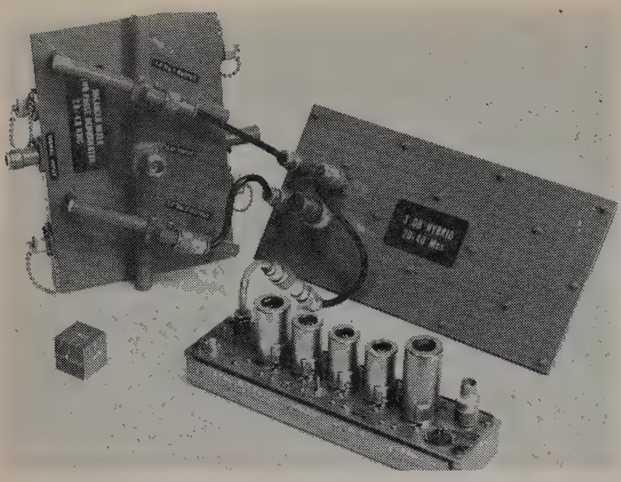

Figure 6 — Photograph of simple outphasing receiver.

shift networks (Figure 2), the signals in the two channels are either in phase or 180 degrees out of phase, depending upon whether the incoming signal has a higher or lower frequency than the local oscillator. A vector adder then combines the two channel outputs, resulting in reinforcement for the signal components and cancellation for image frequency components.

The amount of image suppression provided by the outphasing scheme is insufficient for receivers having wide dynamic range. For example, a receiver having a sensitivity of −90 dbm and only a 20-db image suppression will have a detectable image response for any signal stronger than −70 dbm. To handle this problem, however, the difference between signal and image amplitude can be used to activate special phase-comparison and gating circuits to gate the receiver IF amplifier off during image pulses. Using this technique image pulse rejection as high as 100 db has been obtained.*

III. Practical Realization

The two-phase converter circuit was built and tested in split block coaxial and waveguide configurations. Other techniques such as stripline may also be used.

Figure 3 is a sketch of the coaxial circuit. All of the directional couplers are the quarter-wave electromagnetic-type whose design is due to Oliver[2] and Shimizu[3]. This design was chosen because of its broadband characteristics (typically an octave). The reactive power divider consists of matching quarter-wave transformers in the input and both output lines. The input transformer is a quarter-wave length of 35.4-ohm line and both output transformers are quarter-wave lengths of 70.7-ohm line. A satisfactory impedance match over an octave band was obtained by making the transformers quarter-wave length at the center frequency. The power divider provides equal-amplitude, equal-phase split of the local oscillator signal.

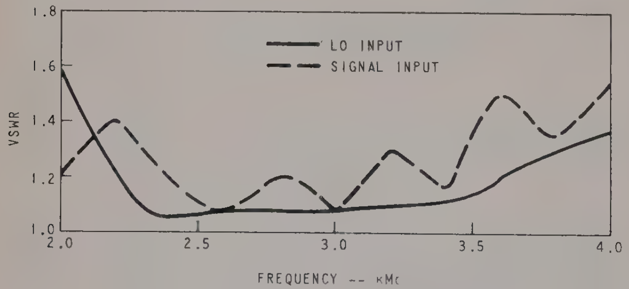

Figure 7 — VSWR of LO and signal inputs to 2.0-4.0 kMc two-phase converter (single-ended mixers).

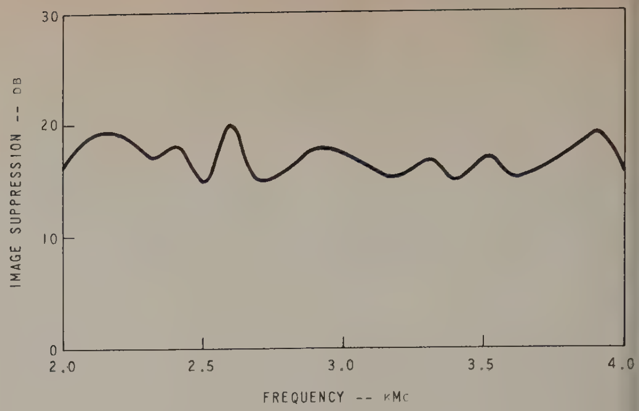

Figure 8 — Outphasing image suppression with two-phase converter (single-ended mixers).

To insure minimum phase error in the circuit it was essential that the line lengths from each output of the 3-db coupler to each mixer be identical. For the same reason, the line lengths from each output of the local oscillator power divider to the mixers were also made identical.

One waveguide unit was designed and fabricated in standard RG-52/U guide for the range from 8 to 11 kMc. The 3-db and 10-db couplers were the waveguide multi-hole type.

IV. Converter With Balanced Mixers (2.0 to 4.0 kMc).

A circuit which is identical to the one shown in Figure 3, except that the single-ended mixers were replaced by balanced mixers, was designed as an improvement to the basic circuit. The balanced mixers discriminate against local oscillator noise and offer additional reductions in signal ambiguities; however, mechanical complexity is greater and fabrication costs higher. An open face photograph of this unit is shown in Figure 4.

V. Basic Limitations

It has been mentioned that the 90-degree phase proper-

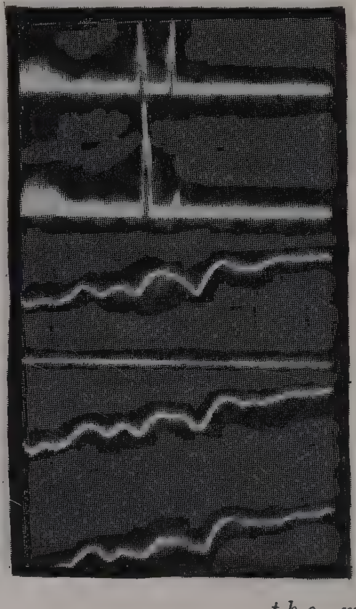

Figure 9 — Two-phase converter performance (2.0-4.0 kMc).

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* *Only about 12 db image suppression from the outphasing circuitry is required for operation of the pulse gating circuitry.*

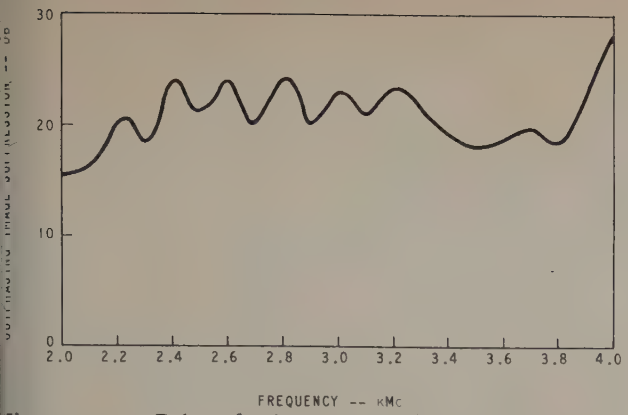

Figure 10 — Balanced mixer two-phase converter image suppression.

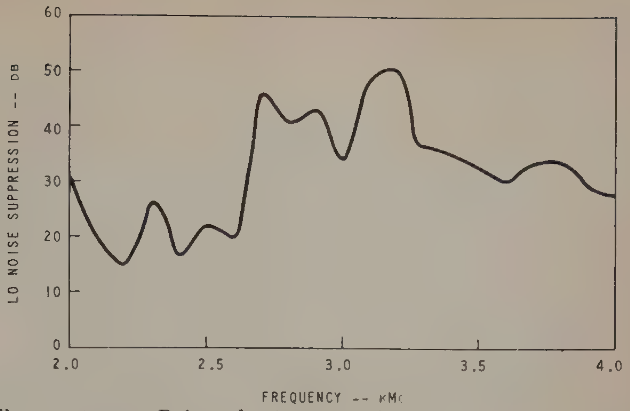

Figure 11 — Balanced mixer two-phase converter LO noise suppression.

y of the 3-db hybrids and the differential 90-degree phase shift in the IF channels are essential in the image outphasing system. If the phase differential deviates from 90 degrees in the RF and IF circuitry or if the amplitudes of the signals reaching the IF adder are not equal, the image will not cancel entirely. Thus, the amount of suppression realizable by the basic outphasing scheme is limited. Figure 5 shows how image outphasing suppression is degraded by phase and amplitude errors.[4]

It is necessary to use a hybrid which yields minimum phase-shift error and minimum amplitude unbalance over a broadband. Oliver[2] showed that the output of a quarter-wave length 3-db electromagnetic coupler are always in phase quadrature, but that the relative amplitudes are frequency dependent. At the band edges, for an octave bandwidth, the ratio of the output amplitudes is approximately .87:1. Such unbalance lowers the maximum theoretical image suppression (infinite), to about 25 db at the edges of a 2:1 band. However, other aspects of the receiver, such as mixer crystal dissimilarities and phase and amplitude errors in the IF circuitry, limit the outphasing image suppression to about 20 db.

The bandwidth of the waveguide converter is ultimately limited to the useful waveguide bandwidth.

VI. A Simpler Outphasing Receiver

An alternative system which requires only one IF amplifier was also designed and tested. A 3-db electromagnetic coupler was designed at the intermediate frequency to provide the 90-degree phase shift required at that frequency. A photograph of this receiver is shown in Figure 6.

This system yields an average of 25-db outphasing image suppression over a 2:1 RF band. It does not require matched IF preamplifiers; however, additional circuitry would be required for IF gating.

VII. Experimental Results

Important performance parameters, such as the input VSWR for the signal and local oscillator inputs to the two-phase converter, and the level of outphasing image suppression were recorded for converters in each frequency band. The degree of isolation between the signal and local oscillator inputs was recorded since this measurement indicates the level of local oscillator radiation from the converter. In general, the VSWR for both inputs was under 1.5 for nominal local oscillator drive to the mixer crystals. Outphasing image suppression for the converter used with the two-channel IF scheme averaged 15-db.

Typical performance curves of a converter designed for the 2.0 to 4.0 kMc band are shown in Figures 7 and 8. An oscilloscope presentation of operation with a QK691 local oscillator sweeping the frequency band is shown in Figure 9. The trace at the top shows receiver operation without image suppression; therefore, signal and image are of equal amplitude. The second trace shows the image suppressed by outphasing circuitry. The incoming signal was at a frequency of 3.0 kMc. The third trace is a plot of local oscillator power output. The bottom two traces are plots of crystal current from the two mixers.

The balanced mixer converter was tested for image suppression with a 30-Mc hybrid which furnished the IF phase shift. A plot of image suppression is shown in Figure 10. Suppression of local oscillator noise was also measured; the results are shown in Figure 11.

VIII. Conclusions

Suppression of image signals in voltage-tuned receivers presents new problems to the circuit designer. The well-known method of using a mechanically-tuned bandpass filter to pass the signal and reject the image is not applicable because of the rapid scan rates involved. The present state-of-the-art in electronically-tuned filters leaves much to be desired in terms of the image rejection desired in most practical receivers.

When used with appropriate IF circuitry, the two-phase converter provides an effective interim solution to the image problem for pulse signals since it makes octave-bandwidth, image-suppression receivers feasible. The outphasing method of image suppression is not limited in tuning rate and is free from the severe tracking problems of other methods. Present designs allow the fabrication of two-phase converters operating over a wide range of microwave frequencies.

References

1 *R. B. Wilds, "An S-Band Two-Phase Demodulator" Volume II, Part 1, 1958 WESCON Convention Record.*

2 *B. M. Oliver, "Directional Electromagnetic Couplers," Proc. IRE, v. 42, No. 11, pp. 1686-1692, November, 1954.*

3 *J. K. Shimizu, "Strip-Line 3-db Directional Couplers," Vol. 1 part 1, 1957, WESCON Convention Record.*

4 *P. Fire, "Practical Limitations of Image Rejection by Phase Cancellation," Memorandum EDL-548, Sylvania, EDL, Mountain View, California, May, 1958.*

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THE "CROSS-OVER" DIRECTIONAL COUPLER

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A cross-over hybrid is normally shown as four sections of transmission line arranged as a reentrant network and with a cross-over of the two-wire line in one of the sections to obtain a 180° phase reversal. The characteristic impedance, Z_o, of each line, is normally 70 ohms if each output arm is 50 ohms and an impedance match is to be obtained. The hybrid is then essentially a 3 db coupler with extremely good broadband characteristics.

It has been proposed that a broadband directional coupler may be obtained if the characteristic impedance of the various lines were changed to Z_1, and Z_2, as shown in Figure I. The only restriction on Z_1 and Z_2 is that both values must be greater than Z_o.

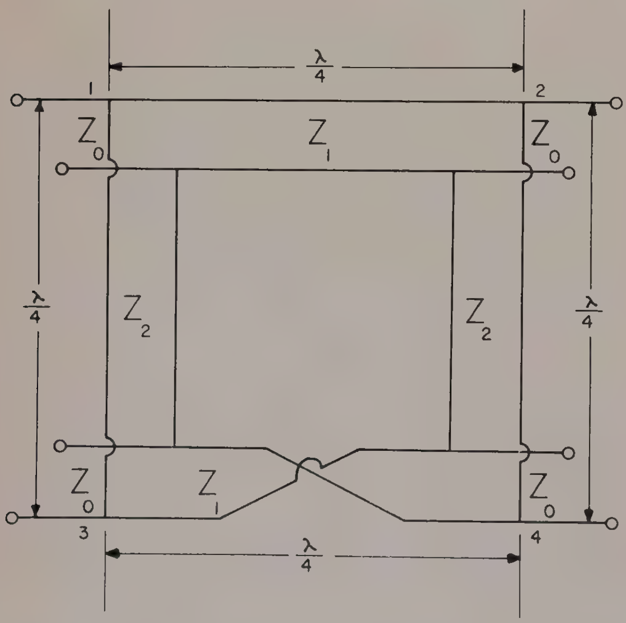


Figure 1 — Cross-over directional coupler.

If each length of transmission line is replaced by an equivalent frequency sensitive π network (Figure 2) then the equivalent circuit of the hybrid, including arm admittances, may be drawn (Figure 3).

The nodal admittances are now evaluated in genera terms, as follows:

$$Y_{11}=Y_{22}=Y_{33}=Y_{44}=1+j\ (k_1+k_2)\ [\tan\theta_1-\mathrm{Csc}\ \theta_2]=Y_A=1-j\frac{(k_1+k_2)}{\tan\theta_2}$$

$$Y_{13}=Y_{24}=j\ k_2\ \mathrm{Csc}\ \theta_2=Y_B$$

$$Y_{12}=j\ k_1\ \mathrm{Csc}\ \theta_2=Y_C$$

$$Y_{34}=-j\ k_1\ \mathrm{Csc}\ \theta_2=-Y_C$$

$$Y_{14}=Y_{23}=O.$$

For a driving current, I_N, into node 1 the matrix equation may be written as follows:

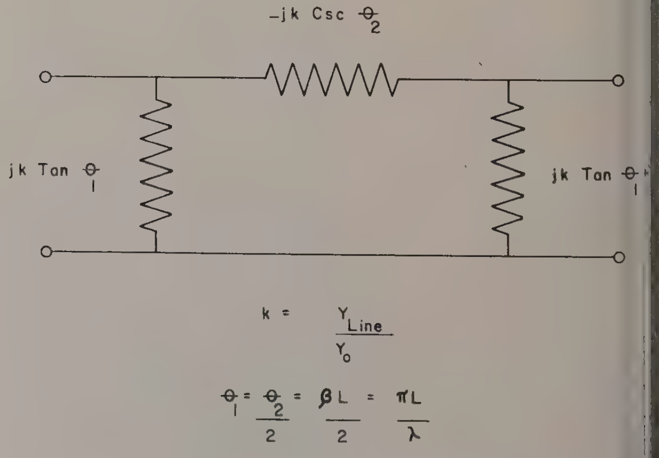


Figure 2 — Equivalent π representation of transmission lin

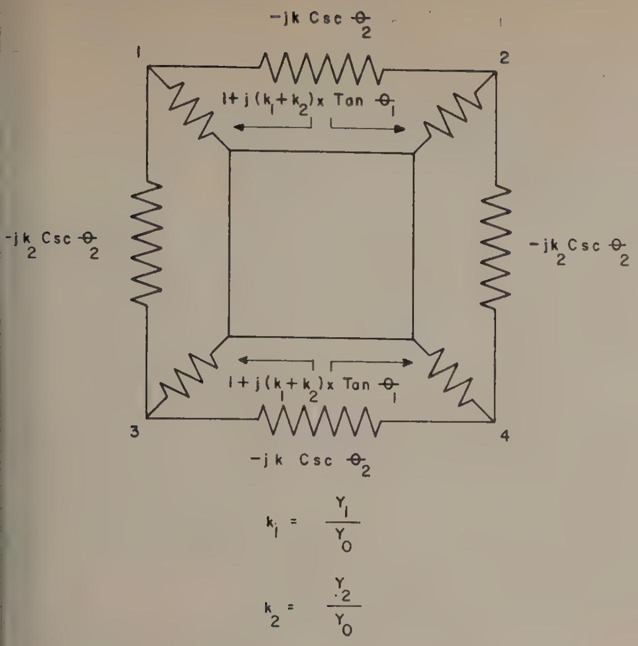


Figure 3 — Equivalent schematic network of coupler.

$$\begin{Vmatrix} I_N \\ O \\ O \\ O \end{Vmatrix} = \begin{Vmatrix} Y_{11} & Y_{12} & Y_{13} & Y_{14} \\ Y_{21} & Y_{22} & Y_{23} & Y_{24} \\ Y_{31} & Y_{32} & Y_{33} & Y_{34} \\ Y_{41} & Y_{42} & Y_{43} & Y_{44} \end{Vmatrix} \times \begin{Vmatrix} V_1 \\ V_2 \\ V_3 \\ V_4 \end{Vmatrix}$$

or

$$\begin{Vmatrix} I_N \\ O \\ O \\ O \end{Vmatrix} = \begin{Vmatrix} Y_A & Y_C & Y_B & O \\ Y_C & Y_A & O & Y_B \\ Y_B & O & Y_A & -Y_C \\ O & Y_B & -Y_C & Y_A \end{Vmatrix} \times \begin{Vmatrix} V_1 \\ V_2 \\ V_3 \\ V_4 \end{Vmatrix}$$

he nodal voltages may now be evaluated:

$$V_1 = \frac{I_N Y_A}{D}\left[Y_A^2 - Y_B^2 - Y_C^2\right]$$

$$V_2 = -\frac{I_N Y_C}{D}\left[Y_A^2 - Y_B^2 - Y_C^2\right]$$

$$V_3 = -\frac{I_N Y_B}{D}\left[Y_A^2 - Y_B^2 - Y_C^2\right]$$

$$V_4 = O$$

$$Y_A^2 - Y_B^2 - Y_C^2 = \frac{2}{\text{Sine }\theta_2}\left[\frac{1 - \text{Cos}^2\theta_2(1 + k_1k_2)}{\text{Sine }\theta_2} - j\,(k_1 + k_2)\text{Cos }\theta_2\right]$$

nd D is the determinant of the admittance matrix, where

$$)= Y_A^4 + Y_B^4 + Y_C^4 - 2\,Y_A^2\,Y_B^2 - 2Y_A^2\,Y_C^2 + 2\,Y_B^2\,Y_C^2$$

$$= \left[Y_A^2 - Y_B^2 - Y_C^2\right]^2$$

Note that $V_4 = O$ in general terms and is therefore in-ependent of frequency or the relative values of Z_1 and 2. *This indicates infinite isolation between opposite rms of the device.*

Now to set the condition for an impedance match (VSWR=1) at f_o, evaluate V_1 at f_o:

$$\theta_1 = \frac{\pi}{4}$$

$$\theta_2 = \frac{\pi}{2}$$

$$\tan\theta_1 = 1;\ \text{Csc }\theta_2 = 1$$

$$Y_A = 1$$

$$Y_B = j\,k_2$$

$$Y_C = j\,k_1$$

$$\text{then } V_1 = \frac{I_N}{k_1^2 + k_2^2 + 1}$$

$$Y_{1n} = \frac{I_N}{V_1} = k_1^2 + k_2^2 + 1$$

But $Y_{in} = 2$ for an admittance match since the Y_0 of the generator was included in the treatment of the network.

$$\text{so:}\quad Y_{in} = (k_1^2 + k_2^2) + 1 = 2$$

$$\textbf{or}\quad k_1^2 + k_2^2 = 1$$

The equation indicates that k_1 and k_2 must both be less than unity. (Both Z_1 and Z_2 are greater than Z_0).

We can now define coupling C'_{1-2} in general terms:

$$C'_{1-2} = \left|\frac{V_2}{V_{inc}}\right| \text{ where } V_{inc} = V_1 \text{ @ } f_o \text{ (matched condition)}$$

$$\text{@ } f_o:\quad V_{inc} = V_1 = \frac{I_N}{G_T} = \frac{I_N}{2}$$

$$\text{and } V_2 = \frac{-I_N\,Y_C}{[Y_A^2 - Y_B^2 - Y_C^2]}$$

Evaluate and simplify denominator

$$\text{Then } \frac{V_2}{V_{inc}} = -2\frac{Y_C}{[Y_A^2 - Y_B^2 - Y_C^2]}$$

$$\frac{V_2}{V_{inc}} = \frac{-j\,k_1}{\underline{X}}$$

$$\text{Now define } C_{1-2} = \left|\frac{V_{inc}}{V_2}\right| = \frac{1}{k_1}\,|\underline{\overline{X}}|$$

where

$$=|\overline{X}|\quad\left[1+\left(\frac{\text{Cos}^2\theta_2\, k_1\, k_2}{\text{Sine}\ \theta_2}\right)^2\right]^{\frac{1}{2}}=\left[1+\left(\frac{k_1\, k_2\, \text{Cos}\ \theta_2}{\tan\theta_2}\right)^2\right]^{\frac{1}{2}}$$

Expressing Coupling in db therefore

$$C_{1\text{-}2}=20\ \log_{10}\frac{1}{k_1}|\overline{X}|$$

$$\text{or}\ C_{1\text{-}2}=20\ \log_{10}\frac{1}{k_1}+10\ \log_{10}\left[1+\left(\frac{k_1\, k_2\, \text{Cos}\ \theta_2}{\tan\theta_2}\right)^2\right]$$

The first term represents the nominal coupling at f_o while the second function is the variation about nominal with change in frequency.

Redefining:

$$\triangle=10\ \log_{10}\left[1+\left(\frac{k_1\, k_2\, \text{Cos}\ \theta_2}{\tan\theta_2}\right)^2\right]$$

Note that if the Coupling is very loose (40 db or greater)

$$k_1\rightarrow 0$$

$$\text{and}\ \triangle\rightarrow 0\ \text{db.}$$

Also for values of θ_2 close to $\frac{\pi}{2}$

$$\triangle\rightarrow O.$$

The above discussion indicates a device which possesses basically flat coupling over extremely broad bandwidths

$C_{1\text{-}3}$ can also be evaluated:

$$C_{1\text{-}3}=20\ \log_{10}\frac{1}{k_2}+10\ \log_{10}\left[1+\left(\frac{k_1\, k_2\, \text{Cos}\ \theta_2}{\tan\theta_2}\right)^2\right]$$

The following table of representative values of Couplings at f_o, has been evaluated from the above equations:

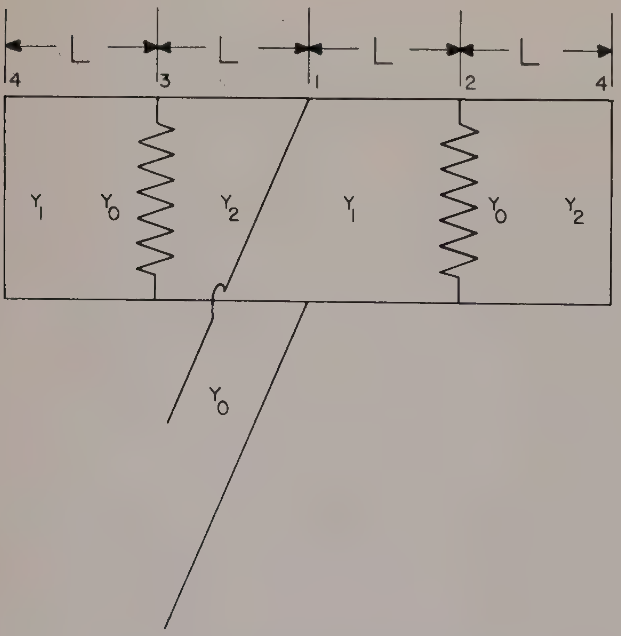


Figure 4 — Bisected hybrid seen at arm 2.

$C_{1\text{-}3}$	Coupled line Z_2	$C_{1\text{-}2}$	Z_1 Main line
3.0 db	$\sqrt{2}\, Z_o$	3.0 db	$\sqrt{2}\, Z_o$
4.8 db	$1.73\ Z_o$	1.8 db	$1.23\ Z_o$
10 db	$3.17\ Z_o$	.44 db	$1.055\ Z_o$
20 db	$10\ Z_o$	.04 db	$1.005\ Z_o$
40 db	$100\ Z_o$	0 db	$1.000\ Z_o$

Note that for loose values of Coupling (40 db) Z_2 becomes prohibitively high.

The variation in coupling with frequency $\triangle$, has also been computed for the representative case of a bandwidth of one octave (frequency range of 2:1). This data is presented in the following table:

$C_{1\text{-}3}$@f_o	$\triangle C_{1\text{-}3}$	$C_{1\text{-}2}$@f_o	$\triangle C_{1\text{-}2}$
3.0 db	+.09 db	3.0 db	+.09 db
4.8 db	+.065 db	1.8 db	+.065 db
10.0 db	+.02 db	.44 db	+.02 db
20.0 db	0 db	.04 db	0 db
40.0 db	0 db	0 db	0 db

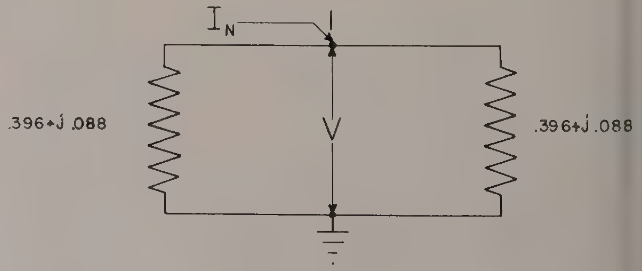
It can again be seen that the device exhibits almost total insensitivity to frequency.

The directivity of the Coupler could be defined in terms of the ratio of V_2 to V_3. It has been shown, however, that $V_4=0$ with input at node 1. Since the hybrid exhibits symmetry about diagonals through nodes 1-4 and nodes 2-3, it can be concluded that $V_3=0$ with input at node 2 and vice-versa. *In other words, directivity is infinite and independent of frequency or the relative values of k_1 and k_2.*

Coupling may also be computed using a specific technique which also easily determines the input VSWR at arm 1.

Since $V_4=0$, node 4 is essentially shorted to ground and the network can then be unfolded as shown in Figure 4.

If we can consider the case of $C_{1\text{-}2}=C_{1\text{-}3}=3$ db, and we facilitate computations with a Smith Chart, we evolve the following network at the input to node 1 (normalized to Y_o).



$$\frac{Y_{in}}{Y_o}=2(.396+j\ .088)=.792+j\ .176$$

$$\text{VSWR}=1.36$$

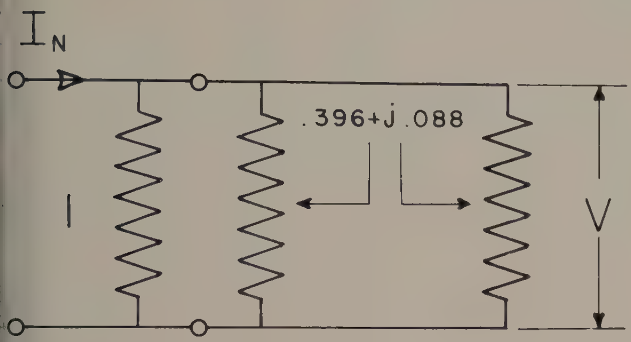
Coupling may be ascertained in two ways.

A.) Since admittances (left and right) are equal, power splits up evenly and arms 2 and 3 receive power 3.0 db down from the input. The ratio of

P_{input} to P_{inc} is obtained from the reflection loss corresponding to a VSWR of 1.36. This is seen to be .1 db (approx.).

Consequently $C_{1\text{-}2}=C_{1\text{-}3}=3.1$ db and $\triangle \cong .1$ db.

B.) Redrawing the network and including the generator.



$$P_2 = |V|^2\ (.396)$$

but

$$V_2 = \frac{I_N}{[1+2\ (.396+j\ .088)]} = \frac{I_N}{1.792+j\ .176}$$

$$V_2{}^2 = \frac{I_N{}^2}{3.25}$$

$$P_2 \doteq \frac{I_N{}^2\ (.396)}{3.25}$$

$$V_{inc} = \frac{I_N}{2}$$

$$P_{inc} = \frac{I_N{}^2}{4}$$

$$\text{Then } C_{1\text{-}2} = C_{1\text{-}3} = 10 \log_{10} \frac{P_{inc}}{P_2} = 3.12 \text{ db}$$

If the 40 db case is considered it can be shown that

$$\text{VSWR} \cong 1$$

$$\triangle \cong 0 \text{ db}$$

at the ends of a one octave band.

Other values of Coupling check in a corresponding nanner.

A number of practical couplers have been built and ested. An early development model is shown in Figure 5. This device is nominally a 10 db coupler with the crossover placed half-way between two of the arms. Additional shielding was placed around the area of the crossover to prevent leakage, but is not shown in the figure. Measurements were made on this device in the 500 to 1000 Mc range. The coupling varied by approximately 2 db about the nominal 10 db value, and the minimum lirectivity was 15 db. VSWR was 1.40 or less over the band.

Conclusions:

The "cross-over" hybrid when used in the prescribed nanner, becomes an extremely broadband frequency insensitive directional coupler with low VSWR, good directivity, and flat coupling characteristics. The only drawbacks noted are the inherent physical difficulties in achieving high values of Z_0 for loose values of coupling and the known poor behavior of "cross-over" devices at very high frequencies (above S-Band).

The "cross-over" hybrid is particularly adaptable to use with twin wire shielded lines and stripline where the cross-over is easily achieved. This is fortunate, since it is easier to achieve a high Z_0 in twin wire line than in a coaxial cable.

The Z_0 required for loose coupling values such as 40 db, is prohibitively high. The problem may be solved in several different ways. One technique would be to use a smaller coupling value such as 20 db in tandem with a 20 db coaxial attenuator. A second approach would be to set up an intermediate input characteristic impedance considerably lower than 50 ohms and step back up to the input line through a tapered section or a series of quarter-wave transformers. The latter technique would undoubtedly decrease the allowable bandwidth.

In coaxial line it is somewhat more difficult to use series fed arms instead of the shunt feeds shown here. However, it is possible to use similar techniques with series feeds where, for loose values of coupling, Z_1 would be a very low value of impedance which is easier to achieve.

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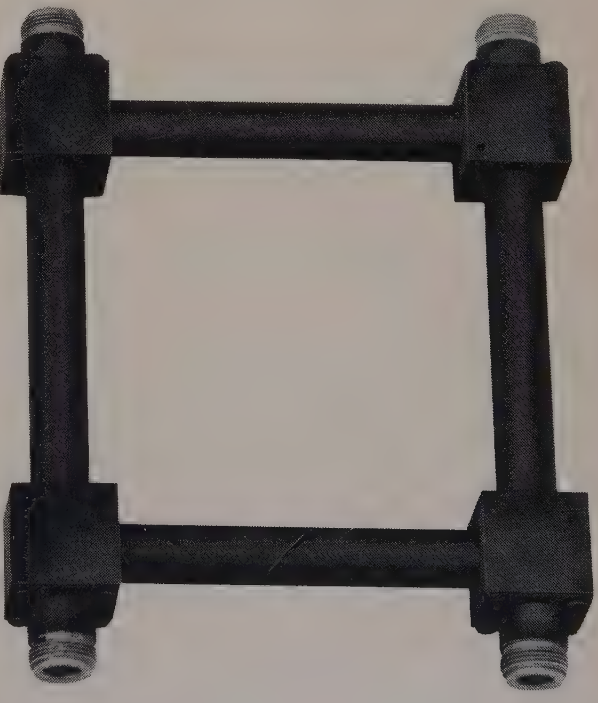

Figure 5 — 10 db cross-over directional coupler for UHF.

RECENT ADVANCES IN LOW-NOISE TRAVELING-WAVE TUBES

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LAST OF TWO PARTS

LOW-NOISE TRAVELING-WAVE-TUBE PERFORMANCE

Operational Low-Noise Traveling-Wave Tubes

Table II lists the pertinent electrical and magnetic-field parameters of many existing RCA S- and L-band tubes capable of noise figures from approximately 3 db to 18 db. All these tubes use relatively low helix voltages (below 500 volts); beam currents are of the order of 150 microamperes for the very-low-noise tubes and one milliampere for the medium-low-noise tubes.

The voltages listed in Table II represent helix voltages optimized for wide-band performance and aperture voltages optimized for low-noise figures. At these voltages, the tubes are absolutely stable. The aperture voltage also controls gain. Variation of E_2 provides primary control of gain with minimum noise figure change; approximately 0.5 db change in gain results from each volt of change of E_2. Variation of E_1 by one volt provides approximately 0.2-db change in gain; small changes in E_3 and E_4 have only negligible effect on gain and noise figure.

The tubes in the two lower-noise-figure groups in Table II have coaxial couplers and ceramic-rod helix supports of the type used in the RCA-6861 shown in Figure 3. The tubes in the two higher-noise-figure groups in Table II have helical couplers, miniaturized electron-tube structures, and helices supported by glass flutes on the inner-wall of the envelope.

Ultra-Low-Noise Operation Below 4.5 db

Some early ultra-low-noise traveling-wave-tube performance was reported in 1958 and 1959; M. Currie[24,25] reported a 2.9-db noise figure for a backward-wave amplifier and Caulton and St. John[26] reported a 3.5-db noise figure for a forward-wave tube. However, 1960 saw the major breakthroughs when Kinaman and St. John[27] reported a minimum tube-noise figure of 2.7 db, and Hodowanec and Wolkstein reported a minimum tube-noise figure of 2.5 db. Both of these measurements were made in S-band with traveling-wave tubes using all possible noise-figure reduction techniques, including beam-noise reduction in both the cathode and transformer regions of the electron gun.

The tube of Kinaman and St. John derived its very low noise figure from an ultra-low-noise electron gun having an impedance-transformer region in combination with a beam-launching region which consisted of an annular cathode and a large number of closely spaced apertures in the cathode vicinity. This arrangement provides a low-velocity drift space immediately following the cathode.

The developmental tube of G. Hodowanec and H.J Wolkstein used a variation of the 6861 tube structure

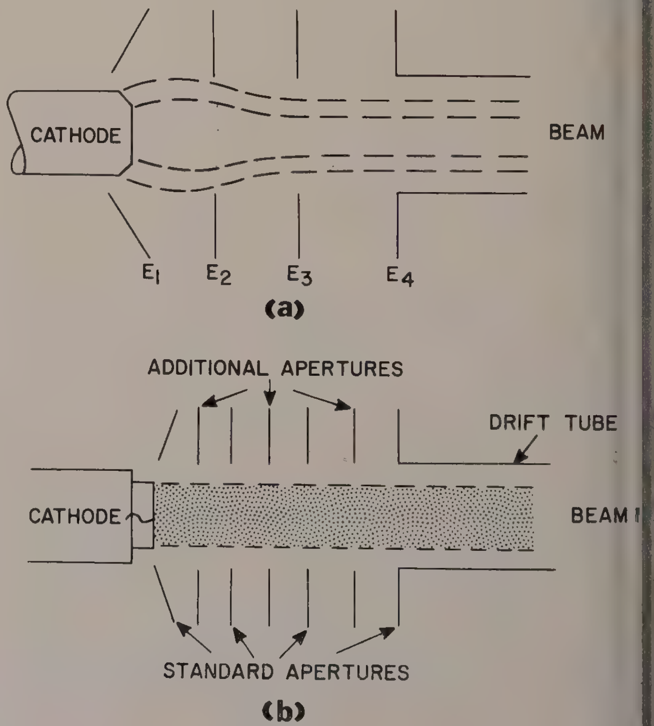

Figure 6 — (a) Detail of an ultra-low-noise electron cathod which provides hollow electron beam from a bevelled cathode edge. (b) Detail of a 7-aperture exponential-transformer gun, in which additional apertures provide increase control of exponential rise to an electron passing through the gun.

TABLE II

ummary of the typical electrical and mechanical parameters of the coaxial-cavity-coupled low-noise tubes; the wide-and helical-coupled low-noise tubes; and the periodic-permanent-magnet-focused low-noise tubes discussed in this aper.

	Nominal Performance				Collector		Aperture Voltages For Low-Noise Tubes						
Frequency (Mc)	Power Output (mw)	Low-Level Gain (db)	Noise Figure (db)	Helix Volt	Volt	Ma	E_1	E_2	E_3	E_4	Duty Factor	Gun Magnetic Field Strength (gausses)	Gun Magnetic Field Strength (gausses)
ltra Low Noise Tubes (under 4.5 db) — Coaxial-Cavity-Coupled — Solenoid Focused													
2700-3500	1	25	4.5 Max.	370	500	0.2	6	14	50	325	CW	800	400
2700-2900	1	25	4 Max.	370	500	0.2	6	14	50	325	CW	800	400
ow Noise Tubes (5-8 db) — Coaxial-Cavity-Coupled — Solenoid Focused													
1100-1400	1	25	7.5	175	200	0.15	0	15	20	130	CW	400	400
1400-1850	1	25	7.5	175	200	0.15	0	15	20	130	CW	400	400
2190-2310	1	20	7	375	400	0.15	0	20	40	215	CW	525	525
2500-4000	1	20	7.5	375	400	0.15	0	20	40	250	CW	525	525
2700-3500*	1	25	6.5	375	400	0.15	0	20	40	200	CW	525	525
3300-3700	1	25	6.5	375	400	0.15	0	20	40	200	CW	525	525
350-4300	1	20	8	375	400	0.15	0	20	40	250	CW	525	525
oderately Low Noise Tubes (7-11 db) — Helical-Coupler Coupled — Solenoid Focused													
2000-4000	5	25	10	420	700	0.5	0	40	45	190	CW	400	400
1000-2000	5	25	10	330	1000	1.0	0	35	30	190	CW	400	400
edium Low Noise Tubes (10-16 db) Helical-Coupler Coupled Periodic-Permanent-Magnet Focused													
1000-2000	10	32	15	320	320	1.2	—50	95	50	70	CW	200	375
2000-4000	15	35	15	475	500	1.0	—30	90	50	200	CW	200	375
4000-7000	10	35	17	830	900	0.7	—90	80	75	600	CW	200	375

RCA 6861

aving a four-aperture ultra-low-noise gun which inluded both an exponential-transformer region, and a oise-reducing beam launching region. This latter region as formed by a cathode disk having a bevelled peripherl outer edge on which an oxide-coating was deposited as shown in Figure 6), and a first aperture with a posive voltage.* A low-noise virtual cathode produced in e beam-launching region provided a hollow electron eam having substantially reduced noise components. he focus solenoid had a tapered magnetic field which roduced an 800-gauss field over the electron gun and a 00-gauss field in the helix region.

A sampling of more than two dozen of these tubes rovided terminal noise figures in the 2.7 to 4-db noise-gure range over frequency bands hundreds of megacyles wide. Tubes using the same type of cathode have lso provided similar results in L-band and lower C-band. ypical gain, saturated power output, and noise figure or the sampling are shown in Figure 7 for a frequency ange of 2700 to 3500 megacycles.

Ultra-low-noise tubes at frequencies higher than S-band ave yielded somewhat larger "lowest" noise figures beause of increased circuit losses and the tube problems rising from the inherent decrease in beam diameter at igher frequencies.

At C-band, Hammer, Laico, Halvorsen and Olsen reported noise figure of 4.2 db from a low-noise electron gun which produced a hollow electron beam. A small pin projecting a short distance from the cathode inside of the hollow beam provided a low-velocity electron drift space in the cathode region.

Nevins has reported a 4.5-db minimum noise figure with a backward-wave traveling-wave amplifier at X-band: and Shaw of Stanford University has achieved a noise figure of 5.2 db with an electron gun designed for cathode-region control.

Low-Noise-Figure Operation in S-band Below the 5- to 6-db Range

Noise figures below the 5- to 6-db range in S-band are difficult to achieve with low-noise traveling-wave tubes not specifically designed and processed for ultra-low-noise operation. Such tubes, operating at 5 db and above, have been in use for several years and derive their low-noise operation from the use of an excellent cathode, from the optimum use of the exponential transformer region in the low-noise electron gun, from the maintenance of maximum precision and care in parts preparation, fabrication, assembly, and processing; and from the use of input couplers of very minimum insertion loss. The new and complex noise-reduction techniques in the beam-launching region are not used.

Many models of S-band tubes using standard exponential-transformer electron guns have been operated with terminal noise figures in the 5- to 5.5-db noise-figure

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This technique of producing a "low-noise" virtual cathode was discussed by J. Berghammer in "Space Charge Effects in Ultra Low Noise Electron Guns," RCA Review, September, 1960.

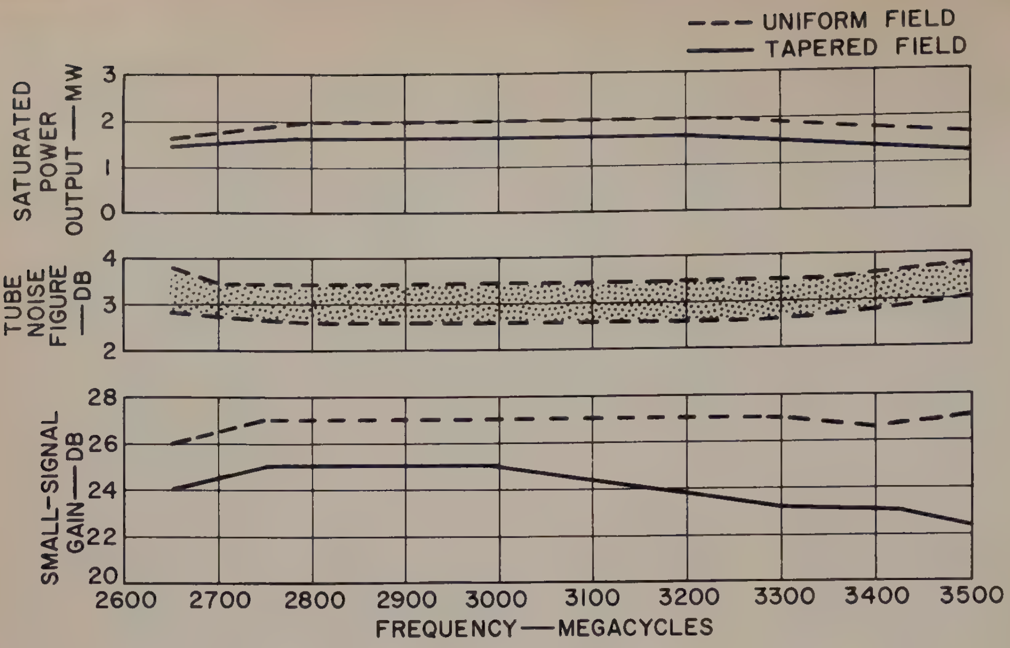

Figure 7 — Saturated power output, tube noise figure and small-signal gain of ultra-low-noise traveling-wave tubes operated in uniform and tapered magnetic fields. The range of noise figures is indicated.

range. Several techniques applied to such tubes have provided noise-figure reduction in the 4- to 5-db range. The careful aging of the cathode over as many as 100 hours created a smooth cathode surface and accounted for a decrease in noise figure in many tubes as large as 0.4 db. In addition, an increase in the strength of the magnetic field from 500 gausses to over 1000 gausses consistently lowered noise figures in the 5-to-5.5-db range to the vicinity of 4.5 db.

An experiment designed to provide optimum control of the exponential potential rise in the transformer region of the gun in a 6861 tube involved the introduction of an additional aperture between each of the four apertures normally used. This arrangement results in a seven-aperture gun, as shown in Figure 6(b). These apertures, which are distant from the cathode, primarily shaped the exponential rise. Models of such tubes, operated in 1200-gauss magnetic fields provided noise figures as low as 4.1 db.

Low-Noise Traveling-Wave Tubes in the 5-to-8-db Noise-Figure Range

When all parameters are optimized for low-noise operation, noise figures of the order of 7 db and as low as 4.1 db have been achieved with low-noise S-band traveling-wave tubes[13] using exponential transformer low-noise guns and low-noise coaxial-cavity couplers antenna-coupled to the tube helix as shown in Figures 1 and 3. Noise reduction is accomplished by the exponential transformer and no ultra-noise techniques are employed.

The four-aperture, three-region exponential transformer gun projects a solid 150-microampere electron beam through a low-loss, silver-plated helix. Large low-loss coaxial couplers having a coupling loss less than 0.4 db are coupled to antennas at each end of the helix. The tube is focused in a 40-pound* solenoid having a magnetic-field region designed to accommodate the large couplers and to provide a uniform magnetic field of approximately 500 gausses parallel to the beam path.

Figure 8 shows the minimum terminal** noise figures

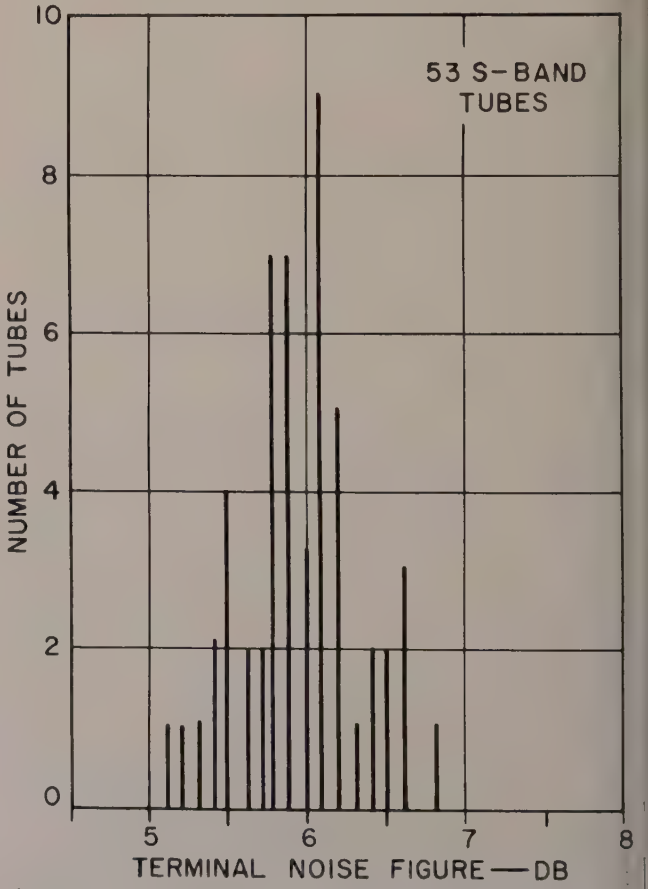

Figure 8 — Terminal noise figure as a function of frequency for 53 S-band tubes.

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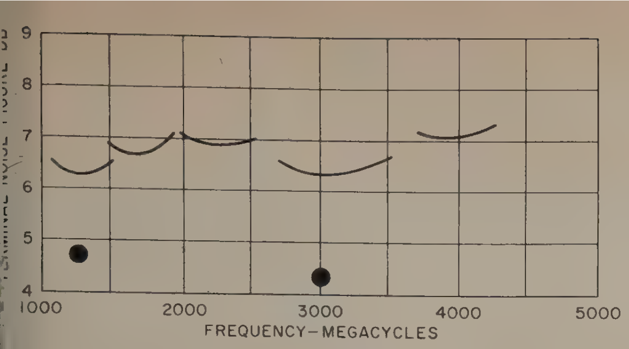
* *An aluminum foil solenoid weighing 20 pounds or a football type permanent magnet weighing more than 50 pounds can also be used.*

** *The terminal noise figure is the true system noise figure measured between input and output terminals. Terminal noise figure is greater than the tube noise figure because it includes the insertion loss of the input coupler. Tube noise figures are only mentioned where accurate measurements of input circuit loss have been made.*



igure 9 — Typical terminal noise figure for a series of medium-bandwidth L- and S-band low-noise tubes. The dot indicates the lowest measured tube-noise figures for the series and the dash line indicates the lowest noise figures achieved.

neasured with a sampling of 53 tubes as reported by Kinaman and Magid.[28] Noise figures as low as 5.1 db were obtained, with most tubes having noise figures of pproximately 6 db.

Other models of these tubes were built with slight nodifications in the length of the coaxial-cavity couplers o permit operation at frequencies as low as 2000 megaycles and as high as 4300 megacycles. As shown in Figure 9, the lowest noise figure of 4.1 db was measured n mid-S-band. In the lower and higher frequency anges of S-band, minimum terminal noise figures of pproximately 5.3 db were achieved.

Several of the sampled tubes were placed on life test o determine the effect of continued tube operation on noise figure. These life tests resulted in electrical performance believed to be unique among microwave amplifiers. Three tubes operated in excess of 19,000 hours without deterioration of noise figure. Figure 10 shows noise figure as a function of hours of operation for one ube which maintained a low and uniform noise figure or 20,000 hours of operation.

Exponential-transformer low-noise electron guns caled for L-band use and coaxial-cavity couplers designed or low-loss coupling in the 1100-to 1400-megacycle and 400-to 1850-megacycle bands were used by Cuccia et l.[29] in the development of L-band low-noise tubes[14]. These tubes operated at a beam current of 150 microamperes and a low helix voltage of 175 volts.

As shown in Figure 11, a sampling of 19 tubes indiated minimum terminal noise figures from 5.1 db to 6.7 db. The terminal noise figure of 5.1 db actually corresponds to a tube noise figure of approximately 4.7 db Typical noise figures obtained at all frequencies in the 1100- to 1750- megacycle frequency range are included in Figure 9. The lowest terminal noise figures occur between 5 and 6 db; the lowest noise figure of 5.1 db at 1210 megacycles. (tube-noise figures are approximately 0.4 db lower than these values).

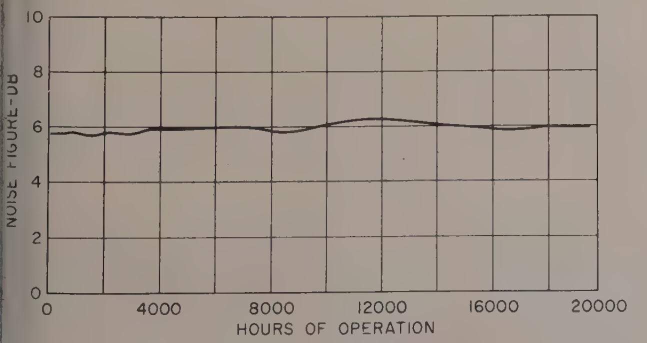


Figure 10 — Noise figure as a function of life for a low-noise S-band tube.

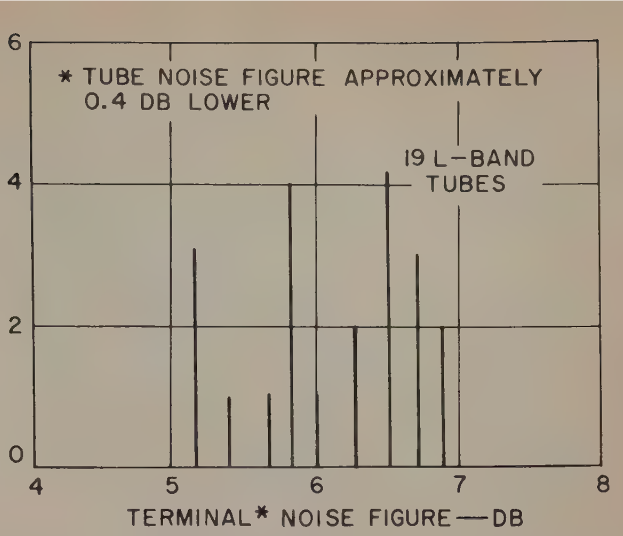


Figure 11 — Terminal noise figures of a series of 19 L-band tubes.

Wide-Band Low-Noise Traveling-Wave Tubes in the 7-to-11-db Noise-Figure Range

In many new traveling-wave tube applications, such as electronic counter measures radar, very wide-band amplification encompassing entire frequency octaves is required, and some increase in noise figure is tolerable.

For low-noise operation and octave-bandwidth coverage at L- and S-band solenoid-focused traveling-wave tubes have been designed [15] which have miniaturized components such as couplers, miniature electron guns, and helices supported in fluted-glass tubing. Helical couplers result in an increase in noise figure because the section of helix preceding the input coupler amplifies the shot noise and because this type of coupler has a somewhat greater loss (1 to 2 db as compared to 0.4 db for a coaxial-cavity coupler). However, for many applications, this increase in noise figure is compensated

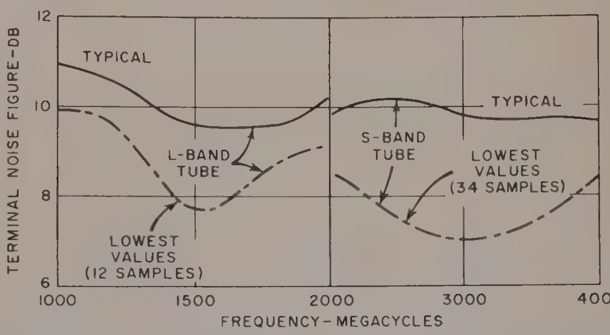


Figure 12 — Terminal noise figures for a series of octave-bandwidth L- and S-band traveling-wave tubes using helical couplers and operated in 400-gauss miniature solenoids.

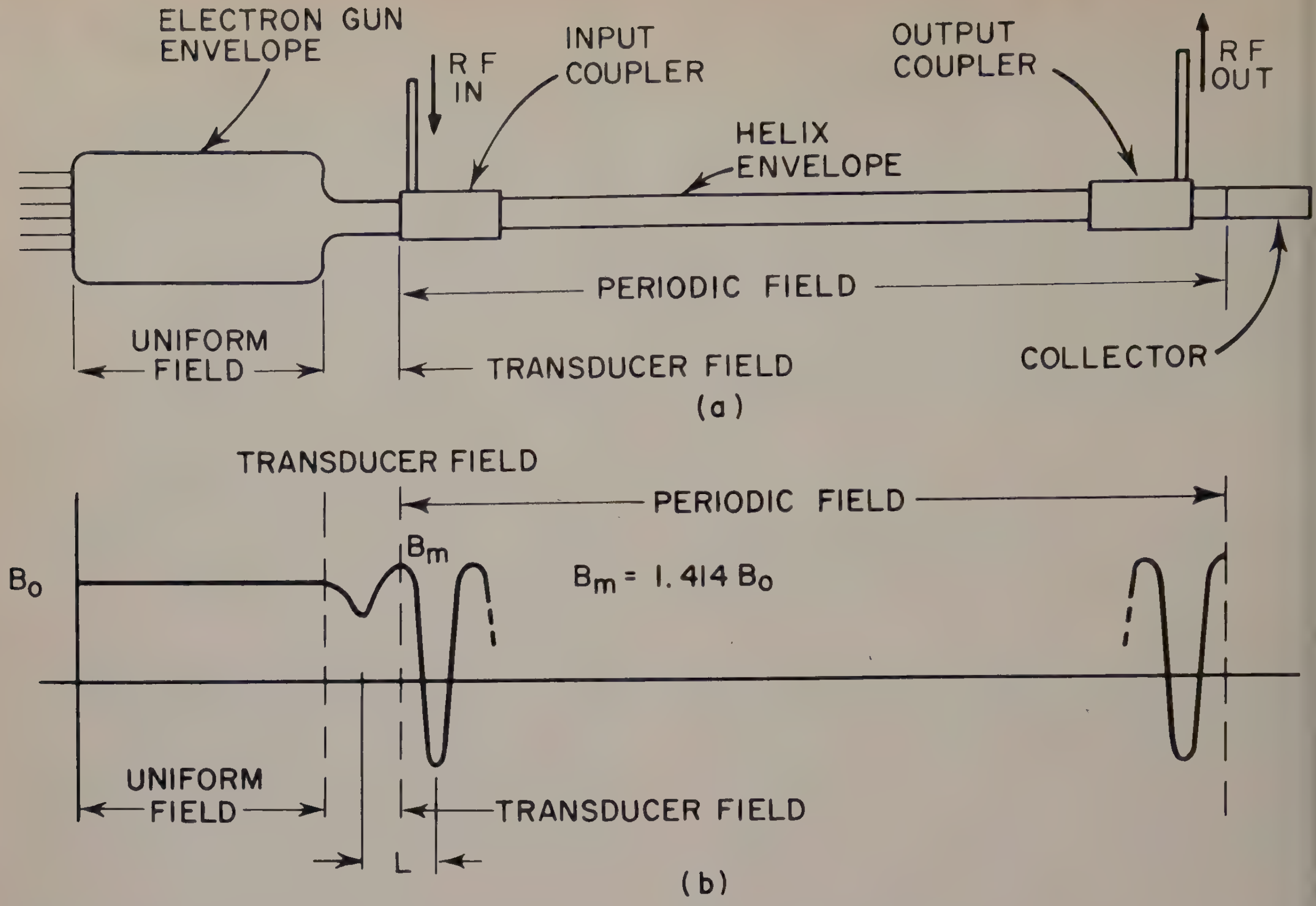


Figure 13 — (a) The basic tube and focusing-field structure of a periodic-permanent-magnet-focused tube, and (b) the resulting magnetic-field pattern.

for by the miniaturization and wide-bandwidth capabilities of the traveling-wave tube.

A miniaturized low-noise electron tube and helical coupler of the type used for L- and S-band tubes, are shown in the bottom of Figure 3. This tube has a gun bulb less than 0.750 inch in diameter, and uses an internally fluted helix envelope less than 0.125 inch in diameter. Tubes of this design have provided noise figures as low as 6 db.

Results of noise-figure tests conducted by Cuccia, Wolkstein, and Napoleon[30] on 34 models of the S-band tube, providing full S-band octave coverage and operating at a helix voltage of 425 volts, showed noise figures between 7 and 11 db over that band. The L-band tube, operating over the full L-band octave with a helix voltage of 325 volts, provided substantially the same noise figures. Both tubes operated in magnetic fields of 400 gausses.

The small size of the tube components made possible the use of aluminum-foil solenoids[31] weighing only 6 pounds. These solenoids (not shown) were housed in a brass cylinder 2 1/2 inches in diameter and 13 1/2 inches long. A magnetic field of 400 gausses was developed in a cylindrical center tube 0.850 inch in diameter when a solenoid voltage of 90 volts and a current of 2.1 amperes were applied. With a higher magnetic field, these noise figures could be lowered, though at sacrifice of solenoid performance and size.

Wide-band low-noise traveling-wave tubes have also been developed for operation across the 4000-to 8000-megacycle and the 8000-to 12000-megacycle frequency bands by Falconer, Krenz, Lindley, and Schumaker. These tubes, which use low-noise guns, waveguide couplers, and ceramic rod support of the helix in ceramic-metal envelopes, are focused by uniform-field permanent magnets. Noise figures in the 7-to 11-db range have been obtained in the above frequency ranges. Reported weights for the tube packages are of the order of 12 pounds for the C-band tube and 8 pounds for the X-band tube.

Periodic-Permanent-Magnet-Focused Low-Noise Tubes in the 10-to-16-db Noise-Figure Range

Periodic-field permanent-magnet (PPM) focusing in a low-noise traveling-wave tube was pioneered by Dr. K. Chang[32] who used such a focus structure in 1954 to obtain a noise figure of approximately 10 db with a one-milliwatt, 3000-megacycle traveling-wave tube.

Chang's approach was to use a low-noise exponential-transformer electron gun emmersed in a uniform magnetic field and a periodic magnet field along the helix.*

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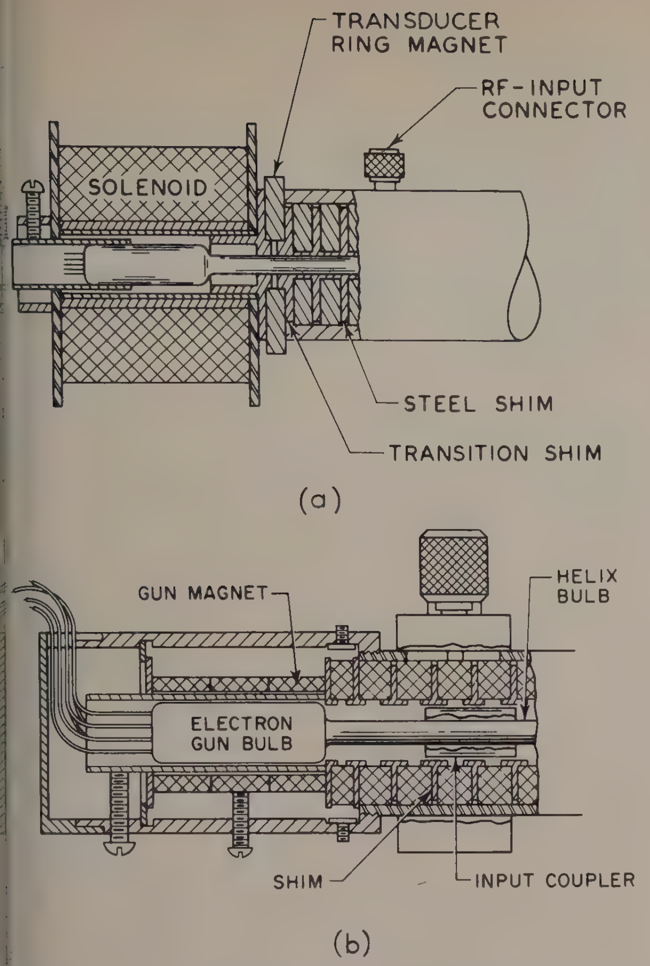
* *In 1956, at the RCA Laboratories, Dr. Chang also tested a similar S-band low-noise tube using low-noise gun immersed in the magnetic field of a solenoid, and a bifilar helix which electrostatically focused the electron beam to the collector without requiring a focus magnetic field. Chang measured minimum noise figures of 13.4 db. Dr. L. A. Roberts was later active with similar tubes designed for L-band at the Huggins Laboratories, and obtained minimum noise figures of the order of 19 db.*



(a)

(b)

Figure 14 — Two techniques for achieving uniform magnetic fields in the electron-gun regions: (a) solenoid, and (b) uniform-field permanent magnet.

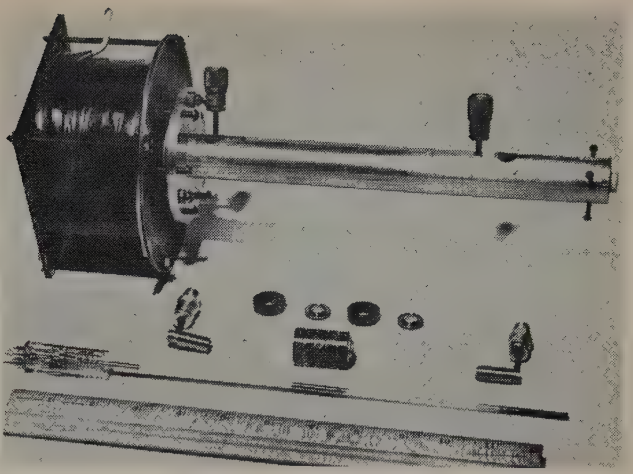


Figure 15 — Components of experimental low-noise tube employing a solenoid over the electron gun and permanent ring magnets for beam focusing along the helix.

The basic tube and focusing-field structure and the resulting magnetic field configuration are shown in Figure 13. The low-noise electron gun provides an electron beam in which noise-figure components at the entrance to the helix are minimized in the same manner as in the solenoid-focused tubes described previously. The use of periodic permanent-magnet focusing following the entrance to the helix causes slight degradation of noise figure; however, the electron-gun design and the manner of focusing in the gun region determine the noise figure of the over-all amplifying structure. In general, noise figures of the order of 10 db are obtainable for tubes designed for saturated outputs of one milliwatt or less, and above 11 db for tubes designed for saturated power output of the order of 10-to 25 milliwatts.

Gun-Focus Techniques in PPM Low-Noise Tubes

Two techniques have been used to develop the uniform magnetic field in the low-noise electron-gun region of the periodically focused low-noise tube; the use of a solenoid and the use of a permanent magnet.

Figure 14(a) shows a cross section of the gun and rf input regions of a periodic-permanent-magnet-focused low-noise tube using a solenoid over the electron gun and a transducer magnet to transduce from the gun field to the helix field. The structure of Figure 14(b) uses a permanent gun magnet and transducer magnet to achieve the same effect. Both of these structures focus the electron beam over the helix portion of the electron tube by means of periodic permanent magnets.

Figure 15 is a photograph of an experimental low-noise traveling-wave tube which operates in both high L-band and low S-band[29]. This tube uses helical couplers, a periodic-permanent-magnet focus structure over the helix, and a solenoid to develop a uniform magnetic field along the electron gun. The tube develops a uniform magnetic field of 350 gausses in the gun region and a peak periodic magnetic field of 485 gausses, and operates with a helix voltage of 460 volts and a beam current of 100 microamperes. The tube produced noise figures as low as 9.6 db, and maintained a substantially constant noise figure of 10.5 db over several hundred megacycles.

Figure 16 shows tube and focus-structure components typical of periodic-permanent-magnet-focused medium-low-noise tubes designed to provide high gain over very wide bandwidths in L-, S- and C-bands. This photograph shows in detail the permanent magnet structures used to provide the uniform gun fields, the transducer magnets, and the periodic magnetic-field magnet and shim structure. The tubes operate with uniform magnetic fields of approximately 200 gausses, over the electron-gun region, and are capable of saturated power outputs in the 10-to-25-milliwatt range. Figure 15 also indicates the reduction in size of the electron tube and focus structure made possible by the use of a periodic-permanent-magnet focus structure of minimum size. Models of these tubes installed in aluminum capsules weigh from 2 to 3 pounds.

Figure 17 shows that models of these tubes exhibit noise figures between 13 and 15 db over the entire L- and S-band octaves, and 14 to 16 db over the 4000-to7000-megacycle frequency band. These higher noise figures result from the use of a gun magnetic field of relatively low intensity (200 gauses) and from the fact that it is very difficult to make the gun magnetic field uniform and constant in intensity from the cathode to the exit of the electron gun.

Low-noise traveling-wave tubes using periodic magnetic fields along the helix and uniform magnetic fields along the low-noise electron gun have been operated in C-band by Mizukaga and Sawayama (Japan) and in X-

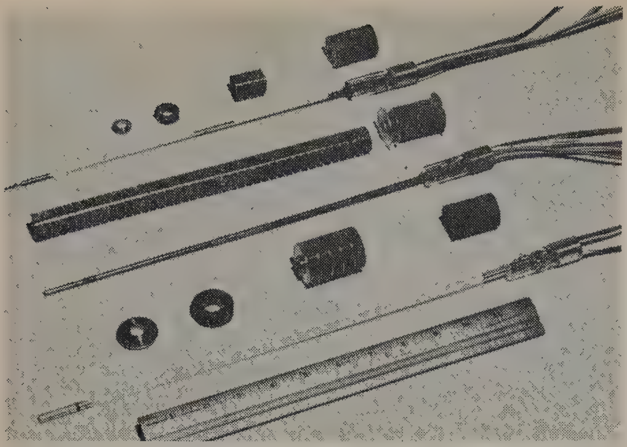


Figure 16 — Tube and focus-structure components of L-, S-, and C-band periodic-permanent-magnet-focused tubes.

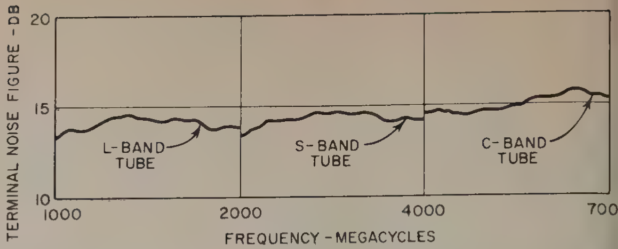


Figure 17 — Terminal noise figure for L-, S-, and C-band medium-low-noise tubes having saturated power outputs in exce of 10 milliwatts.

band by F. Schumaker. The former effort has yielded noise figures of 10 db at 7500 megacycles. F. Schumaker used an electron gun enclosure of substantially the same diameter as the helix envelope (which made possible a PPM structure with increased intensity and improve uniformity of the gun field), and produced noise figure as low as 7 db in X-band in both periodic-field and entirely-uniform-field structures.

Acknowledgment

The authors gratefully acknowledge the guidance an advice of Dr. Stanley Bloom, Dr. Kern, K. N. Chang and Mr. Hans K. Jenny in the preparation of this paper

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* * *

LONG LINE EFFECT IN PULSE COMPRESSION RADAR

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RAYTHEON COMPANY
Wayland • Massachusetts

In a radar set it may happen that an improvement in erformance can be obtained by the use of pulse comression techniques.[1,2] In the simplest case the frequency f a pulse is changed linearly with time over the duration f the pulse, keeping the voltage amplitude of the pulse onstant. On reception, the pulse is fed through a proprly designed filter which enables an effectively increased eak power to be simulated.

One of the microwave problems is to obtain a linear ariation of the output phase of the radiated wave with requency. If the phase output is non-linear, a degradaion of performance may result. This note is concerned vith the non-linearity which may be caused by multiple eflections in the transmision line.

Consider a long length of lossless transmission line from a tunable generator to an antenna. If both the generator and the antenna are matched to the line, the variation of the phase of the radiated output with frequency will be considered linear, Figure 1a. If there is a mismatch at each end of the line then there will be a variation from linear of the radiated phase which this note will compute.

The phase pattern in Figure 1b repeats when the phase shift of the line varies by half a wavelength as the frequency changes. This will happen when the frequency shift is $\triangle f$ as shown in Figure 1b; for coaxial line $\triangle f = \frac{f\lambda_o}{2S}$ and for waveguide $\triangle f = \frac{f\lambda_o}{2S}\,\frac{\lambda_o}{\lambda_g}$ where S is the length of line between the two mismatches, λ, is the mean operating wavelength, f is the mean operating frequency, and λ_g is the mean operating guide wavelength.

The ABCD matrix for a lossless transformer of normalized impedance Z and of phase shift θ

$$\begin{bmatrix} \cos\theta & jZ\sin\theta \\ \frac{j\sin\theta}{Z} & \cos\theta \end{bmatrix} \qquad (1)$$

J. R. Klauder, A. C. Price, S. Darlington, and W. J. Albershein, "The Theory and Design of Chirp Radars," The Bell System Technical Journal, Vol. 39, p. 745, July 1960.

. C. Cook, "Pulse Compression — Key to More Efficient Radar Transmission," Proc. I.R.E., Vol 48, No. 3, March, 1960, p. 310.

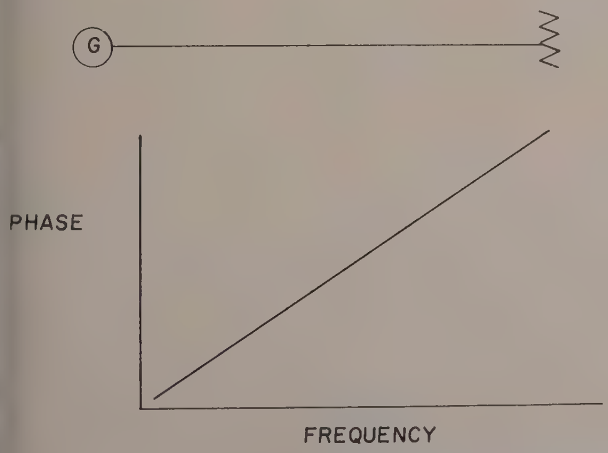

Figure 1a — Long line matched to generator and load.

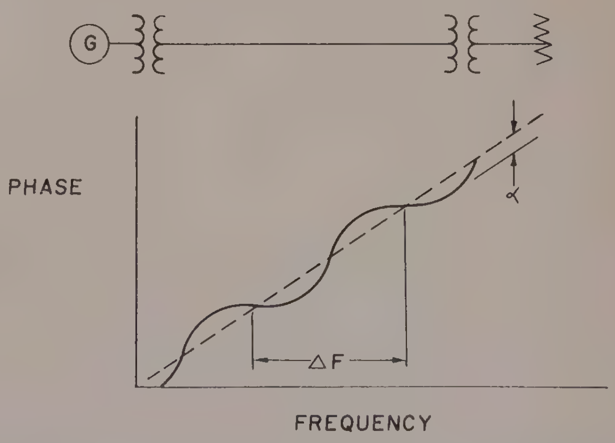

Figure 1b — Long line mismatched to both generator and load.

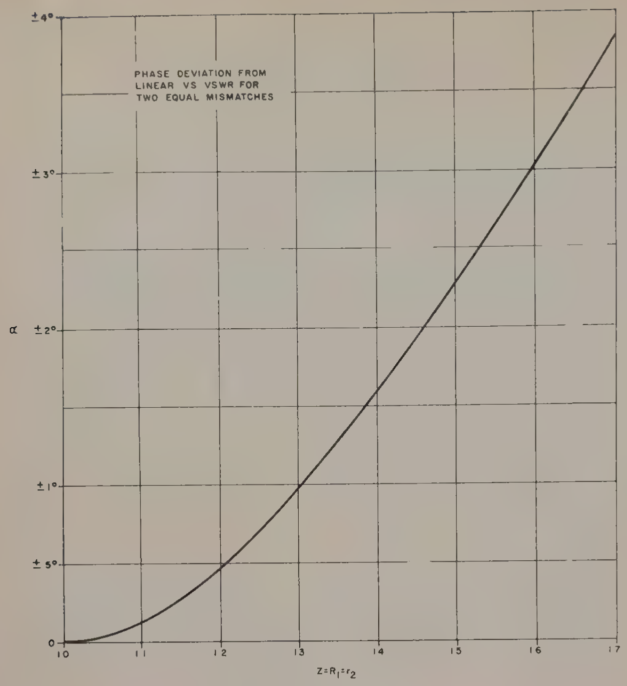

Figure 2 — Phase deviation from linear vs. VSWR for each of two equal mismatches.

The transmitted voltage is then

$$T=\frac{2}{A+B+C+D}=\frac{1}{\cos\theta+j\frac{1}{2}\sin\theta\left(Z+\frac{1}{Z}\right)}=|T|<\phi \tag{2}$$

As a reference phase the phase shift if the transformer impedance is changed to unity is

$$T=\frac{1}{\cos\theta+j\sin\theta}=|T|<\theta \tag{3}$$

The difference between ϕ and θ is the amount the phase may be shifted due to the two mismatches at either end of the transformer and will be denoted by α. The maximum value of α is found by finding where the rate of change of α with frequency is equal to zero keeping Z constant and is given by

$$\tan\alpha=\pm\frac{(Z-1)^2}{\sqrt{8Z(Z^2+1)}} \tag{4}$$

A plot of this angle in degrees as a function of Z ranging from 1.0 to 1.7 is given in Figure 2.

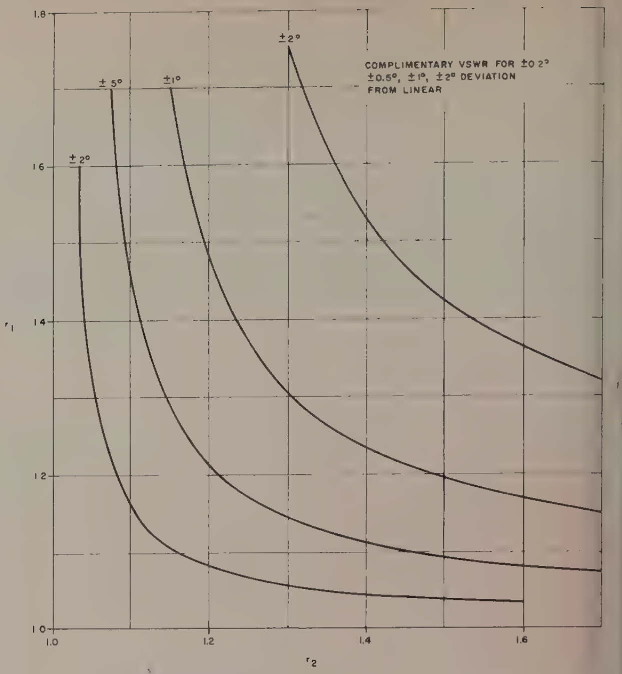

Figure 3 — Complementary VSWR for ±.2°, ±.5°, ±1.0 ±2.0° deviation from linear.

For example, suppose a long transmission line exist with mismatches of 1.3 at each end. The steady stat phase shift of this line may vary by ±1° from that of matched line when the operating frequency is varied s that the overall phase changes by a half wavelength. Th variation in amplitude is not considered in this note. Fo a small change in frequency over a pulse the phase difference from linear can be treated as sinusoidal.

For the case where the input and output standing wav ratios are not the same, but have the values r_1 and r_2 respectively, the factor $\frac{1}{2}(Z+1/Z)$ in Equation (2) is replaced by $\frac{r_1 r_2+1}{r_1+r_2}$ to determine the phase shift. It wil be noticed that when r_1 equals r_2 the two equations ar equal ($r_1=r_2=Z$). Figure 3 plots r_1 vertically and r_2 horizontally. Contours of maximum phase shift of ±.2° ±.5°, ±1°, and ±2° are plotted on this field.

Acknowledgment

The author wishes to thank many of his colleague for their help in this discussion, especially T. A. Weil B. W. Leake, R. A. Campbell and W. M. Hall.

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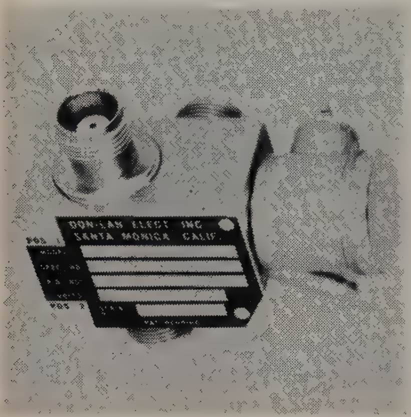


Don-Lan Electronics Inc., Santa Monica, Cal., is now producing a new version of the SA-90 series remotely-controlled SPDT microwave switch. The new model retains the reliability, rugged (MIL-E-5272) construction, small (2 x 1.3 x 2 inches) size and weight (2.5 ounces), and fast (seven millisecond) fail-safe operation of the original design.

The new design has improved high frequency performance achieved by modifying the rf cavity. The new features of the SA-90-series switch are now available for use in microwave systems up to six Gc. Extended rf performance over the full one to 10 Gc frequency range which is becoming so important in aircraft, missile and space radar and communication systems will be available shortly.

SA-90 series switches may be tailored for specific system applications. While they normally operate from 28 vdc or 115 vac, 60 or 400 cps, models actuated from other power sources are offered.

Standard rf connectors are series N, TNC or BNC jacks. Plugs and combinations of plugs and jacks of the standard or other common coaxial connectors and coaxitube receptacles can be supplied on order.

Circle Reader Service Card 100

—*mwj*—

FREQUENCY STANDARDS DEVELOPS MICROWAVE OSCILLATOR CAVITY

The newest microwave oscillator cavity developed by Frequency Standards, Asbury Park, N. J., features a ± two Mc calibration accuracy and 0.1 per cent resetability using a direct reading frequency tuning mechanism. The cavity is designed to withstand conditions of extreme shock and incorporates a ruggedized anti-backlash tuning mechanism.

Operating frequency is from 400 to 1000 Mc. When used with 2C36 or similar UHF Triodes, 10 milliwatts of power into a 50 ohm load is achieved. The oscillator also includes a waveguide-beyond-cutoff type attenuator permitting directly calibrated power output from 120 to 0 db below one milliwatt. Power output is monitored by means of bead and disc thermistors in a thermal-compensated bridge.

The oscillator is the heart of the model TS418 Signal Generator which is both CW and pulse modulated. The entire unit is designed to conform to MIL-E-5400. The tube receptacle is designed for quick, easy replacement and the cavity has a long duration RF output stability. Oscillator cavities at higher frequency ranges can be provided for special requirements.

Circle Reader Service Card 101

—*mwj*—

GEISLER LABS OFFERS MINIATURIZED TRAVELING WAVE TUBE

A miniaturized traveling-wave tube is being offered by Geisler Laboratories, Woodland Hills, Cal. This TWT, the model G200P, operates in the C-band frequency range of 4-8 kMc, and provides a power output of 10 milliwatts.

Featuring extremely light-weight packaging for military applications, and ruggedized for a wide variance of environmental conditions, the G200P is representative of a series of TWTs being introduced by Geisler Laboratories.

Circle Reader Service Card 102

—*mwj*—

PORTABLE WATER SUPPLY MAINTAINS OPTIMUM OPERATING TEMPERATURE

A new completely self-contained, portable water supply has been developed for use in maintaining optimum operating temperature of critical equipment. It will hold the temperature of the water supplied to ±1°F. Designated the Powertherm, model E-1147-1, by the manufacturer, Astro Dynamics, Inc., Burlington, Mass., the temperature controlled water supply is housed in a standard radio relay rack, occupies a space of only 28 inches x 22 inches x 15 inches and can be conveniently placed on a standard work bench.

Supplying up to one kw of heat or cooling up to 1½ kw, the Powertherm can be used with a wide range of equipment —communications and radar, control, missile ground support, medical, and plastic, chemical, textile, and photographic processing. It was originally developed for maintaining the temperature of missile guidance controls in the hanger (as part of ground support equipment) and in the laboratory. New applications include the accurate maintenance of "cold plates" of computer systems onto which transistors and thermoelectric devices are mounted, and fast warmup of diverse equipment ranging from electronics to injection molding dies.

The water supply is a closed system with a stainless steel tank holding two gallons and a pump capable of delivering up to 2.7 GPM at 55 psi. Self-sealing quick connectors are provided on the front panel.

Circle Reader Service Card 103

—*mwj*—

EG&G ADDS 70 KV SPARK GAP

A new, ceramic-metal, triggered spark gap with 70 kv hold-off voltage has been added to the line manufactured by Edgerton, Germeshausen & Grier, Inc., Boston, Mass. Designated the GP-15, the device can handle peak currents greater than 10,000 amperes. Triggering is accomplished by a low energy, 25 kv, minimum pulse and delay time is 0.5 microsecond at 80 per cent of maximum hold-off voltage. No filament power is required.

Hermetically sealed in its ceramic envelope, the GP-15 is unaffected by atmospheric conditions. Overall dimensions

(*Continued on page 104*)

3 new Microwave Amplifiers designed by request

*** 1 watt — 12.4 to 18 Kmc**

*** 2 watts — 8 to 12.4 Kmc**

*** 5 watts — 7 to 11 Kmc**

MICROWAVE AMPLIFIER

Available now from Alfred Electronics

FEATURES

- * Rated gain and power output over each range at one setting of controls
- * 30 db gain at rated power; flat response
- * Compact, simple to operate
- * Rack or bench mounting
- * RF connectors out of front or rear

A number of Alfred's customers asked for—and now have—amplifiers with 1 and 5-watt outputs covering the ranges listed above. The new units can be used as broadband power amplifiers; stable power oscillators using external resonant feedback networks; narrowband amplifiers providing more than rated gain and power and for frequency multiplication. Each amplifier consists of a TW tube, its focusing magnet, and a completely regulated supply for obtaining optimum performance from the TW tube.

BASIC DATA	526	527	528
Frequency Range	12.4 to 18 Kmc	8 to 12.4 Kmc	7 to 11 Kmc
Power Output	1 watt	2 watts	5 watts
Gain (Small Signal)	30 db	30 db	30 db
Gain (Saturation)	25 db	30 db	30 db
VSWR (Input/Output)	2:1	2.5:1	2.5:1
RF Connectors	P Band Flange VG-419/U	Type N Female	Type N Female
Price	$4,190	$3,290	$3,290

For more information, call your Alfred engineering representative or drop a line to Palo Alto. Please address Dept. 69

ALFRED ELECTRONICS

3176 Porter Drive
Stanford Industrial Park
PALO ALTO, CALIFORNIA
Phone: DA 6-6496

A PITLOG STALO and other compact instrumentation puts "Terrier" on target!

. . . and other circuit components contribute to the operational capability of **BOMARC, HAWK** and **project SAGE.** Pitlog equipment is also used on the **DEW** Line, for Missile Telemetering at Cape Canaveral . . . and for instrumentation of the T-58 turboshaft engine, APS-95 ground support equipment and ASR airport surveillance radar.

We invite your inquiry for SPEC-file or engineering assistance for any aspect of:

STALOS, STALO or COHOS Testers
Radio Astronomy, Spectroscopy
MTI or Doppler Radar, or their evaluation
Control Electronics, Transistorized Amplifiers
Servo Systems, Frequency Controls
Magnetic Memory Components
Nuclear Material Handling Devices
Aerological and Torque Indicators
Waveguide Mixers

PITOMETER LOG CORP.
237 Lafayette St., New York 12, N.Y.
Advanced Instrumentation Since 1927

Circle Reader Service Card 62

New Products

(*Continued from page 102*)

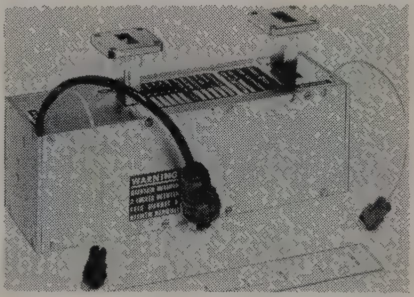
are only 3 7/16 inches diameter x 3 11/32 inches height.

EG&G Spark Gaps are designed primarily as replacements for hydrogen thyratrons in electronic crowbar and high energy switching applications for the protection of radar modulators, high voltage oscillators, heavy power supplies and exploding bridge wire applications. Other Spark Gaps in the EG&G line include the GP-11, with 3.5 kv hold-off voltage, the GP-12 with 25 kv hold-off voltage, and the GP-14 with 40 kc hold-off voltage. All four models are available on an off-the-shelf basis.

Circle Reader Service Card 104

—mwj—

GE DEVELOPS LOW-NOISE TWT AMPLIFIER



A low-noise, metal-ceramic traveling-wave tube amplifier for use in the 7,500-8,500 megacycle frequency range is now available from the Power Tube Department of the General Electric Co., Schenectady, N.Y.

The tube, designated Z-3093, has a maximum noise figure of less than 7.5 db and a saturated power output of five milliwatts across the entire band. Gain is at least 25 db.

The ultra-low noise feature of the Z-3093 makes it ideal for use in very sensitive receivers, especially radiometers. Other applications include counter-measures, microwave relay systems and for input service in radar receivers.

The Z-3093 is supplied as a complete package, including the permanent magnet focusing assembly and waveguide input and output r-f connectors. The complete assembly, which can be mounted in any position, weighs 11.5 pounds. Package dimensions are 9.25 x 4.6 x 3 inches.

Circle Reader Service Card 105

—mwj—

NEW ADVANCE IN MICRO-DEBURRING DISCLOSED

Ultrasonic Systems, Inc., Los Angeles, Cal., announces development of new advanced micro-deburring equipment with the introduction of model UG 500/UT 25s to meet the demands of space age progress for ever-increasing precision and miniaturization of machined parts.

Detection and removal of micro-burr too small to be seen but too large to b tolerated has been a major hurdle i achieving critical mechanical precision.

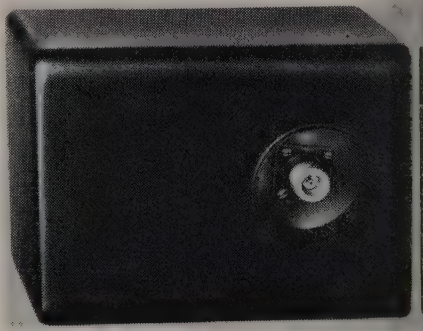
Now, a new USI system provides powe in excess of 200 watts per gallon capabl of removing minute but troublesome met micro-burrs from machined surfaces wit out damaging delicate parts or disturbin close tolerances. Parts to be deburred ar immersed in a liquid medium in which high grade abrasive is suspended. Th liquid is contained in a transducerized $2\frac{1}{2}$-gallon, stainless steel tank, UT 25 which is driven at a frequency of 55 KC by the generator, UG 500. Output of th UG 500 averages 500 watts (1000 watt on peaks).

Major advantages of the ultrasonic ap proach include low cost, no chemical ac tion to damage parts, low labor require ments, high precision and close contro of tolerances. USI scientists are continuing major research and development to furthe refine the process, for example, reducing time required in the cleaning bath, and eliminating follow up ultrasonic cleaning sometimes required to remove small gri from pores of the materials, and rust pre vention required immediately after clean ing.

Circle Reader Service Card 106

—mwj—

SERIES OF RF ATTENUATORS DEVELOPED



A new series of high power RF attenu ators, model AX-100, 100 watts, and model AX-500, 500 watts, is announce by Electro Impulse Laboratory, Inc., Re Bank, N. J.

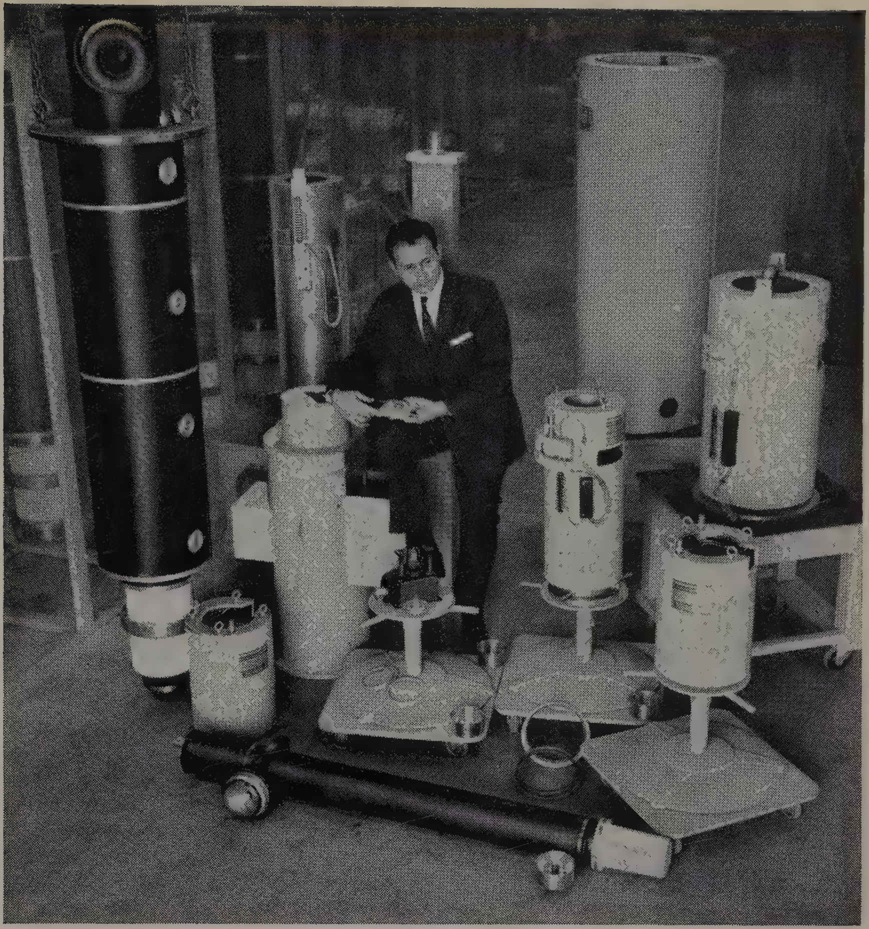
The frequency range is dc-700 Mc and dc-1000 Mc with reduced accuracy. The accuracy is ±.3 db. Standard values o attenuation are 10, 20 and 30 db. Othe values also available.

These attenuators are oil filled, self cooled, resistive devices and are designe to be inserted in a 50 ohm line. Input and output connectors are type "N".

Circle Reader Service Card 107

—mwj—

(*Continued on page 106*)



KLYSTRON AND TWT ACCESSORIES

OR LITTON AND OTHER TUBES

Klystron Focus Coils
TWT Solenoids
Water Loads
Radiation Shields
Cathode Sockets & Fingers

Litton microwave tube accessories have largely been confined in the past to those required by Litton tube users. Now, Litton develops and produces a variety of tube accessories to customer specifications, *regardless of tube manufacturer* or application.

Focus Coils and Solenoids: Foil or wire wound in any size — from low-noise TWT's to super-power klystrons. Epoxy impregnated by vacuum or pressure. One terminal board. One coolant input/output manifold. Leak-resistant cooling systems. Integral lead shielding.

Water Loads: For L through C bands. Seamless aluminum guide construction. Light, short, versatile. Excellent pressure integrity to 50 psia. Super or medium power. Low VSWR with high peak and average power ratings. Typical L-band unit tested to 20 megawatts peak power, 50 KW average power.

Other Litton tube accessories are radiation shields, differential thermopiles, and cathode sockets and contact fingers.

For more data, write to: Litton Industries, Electron Tube Division, San Carlos, California. Or telephone LYtell 1-8411.

LITTON INDUSTRIES
Electron Tube Division
MICROWAVE TUBES AND DISPLAY DEVICES

Circle Reader Service Card 63

Lincoln Laboratory is supplementing its staff. The Laboratory is engaged in basic air defense research for the space age. This expanding program is a natural outgrowth of our advanced research and development in the fields of Radio Physics, Radar, Systems Studies, Satellite Surveillance, Computer Technology and Solid State Physics. Senior scientists are invited to join the Laboratory in solving urgent problems of importance to the defense of the United States.

The Laboratory is seeking qualified specialists in:

RADIO PHYSICS and ASTRONOMY

NEW RADAR TECHNIQUES

SOLID STATE PHYSICS and METALLURGY

- A more complete description of the Laboratory's work will be sent to you upon request.

All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

Research and Development
LINCOLN LABORATORY
Massachusetts Institute of Technology
BOX 25
LEXINGTON 73, MASSACHUSETTS

New Products

(*Continued from page 104*)

MOTOROLA OFFERS S-BAND PARAMETRIC AMPLIFIER

The Motorola Solid State Electronics Department, Scottsdale, Ariz., has announced the availability of a high-gain, low-noise parametric amplifier designed for operation at 2480 Mc - 2520 Mc in S-Band

Outstanding characteristic of this new device is a design permitting universal application of the basic amplifier as: a broadband parametric amplifier; a narrow-band parametric amplifier; or as a parametric up-converter with output at X-Band.

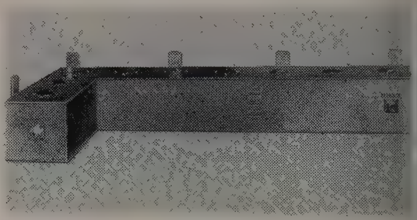
Designated model SPA01, the Motorola device utilizes a single, silicon p-n junction diode as the variable-capacitance energy storage element, a miniature ferrite circulator for input-output signal separation, and filters at the input and idler circuits to permit extremely wideband operation.

The Model SPA01 S-Band parametric amplifier is one of a series of Motorola parametric amplifiers designed for use in VHF, UHF, and microwave receivers where exceptionally low noise figure and wide bandwidth are desired. Possible applications include radar, telemetry, microwave relaying, radio astronomy and other systems.

Circle Reader Service Card 108

—*mwj*—

HIGH POWER DIPLEXER INTRODUCED BY RANTEC



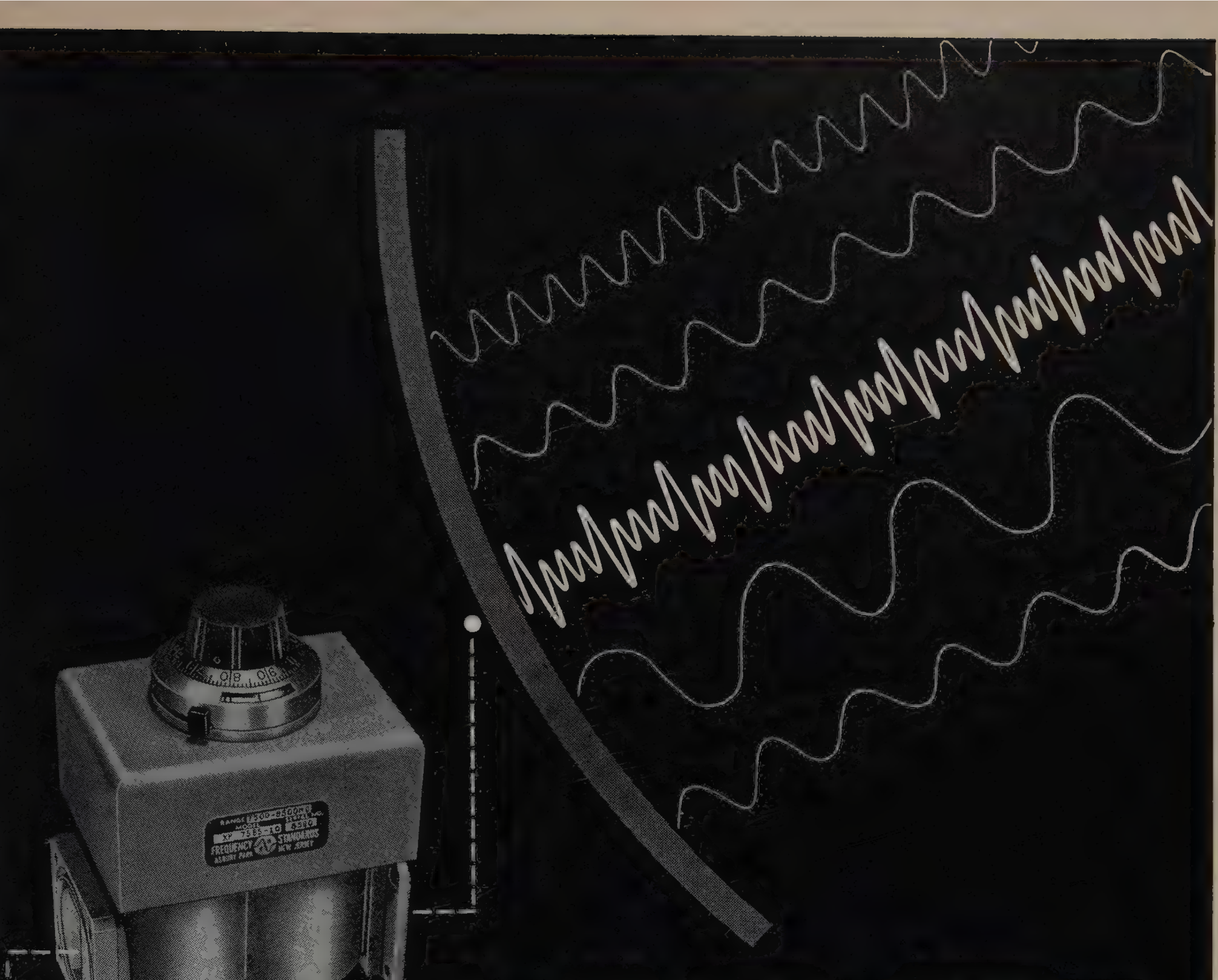
Rantec Corp., Calabasas, Cal., announces the availability of the FUU-401 diplexer. The unit has been used to provide extremely high isolation between a high power transmitter and a receiver operating on the same antenna system. It was designed specifically for the 800-1000 Mc band being used for satellite and deep space probes. 120 db isolation between the transmitter and receiver is obtained with a receiver pass band loss of only 0.3 db. The transmitter arm of the diplexer has an insertion loss of less than 0.1 db. The pass band widths are approximately 20 Mc.

The unit is designed for on-site applications and other models are available to cover different frequency band requirements.

Circle Reader Service Card 109

—*mwj*—

(*Continued on page 108*)



Tunable-X Band Filters

MAXIMUM REJECTION ● LOW INSERTION LOSS
● DELIVERY FROM STOCK

Now, Frequency Standards, world leader in microwave filter technology, introduces a new series of precision tunable bandpass filters covering the range of 7 to 12.5 Gc — assembled and delivered from stock in two weeks or less!

These filters feature a bandwidth of 8 to 12 mc at 3 db and 60 mc at 30 db with 2 db insertion loss . . . VSWR of 1.5 max. at F_0 . . . temperature stability of 3 cps/Mcs/°C maximum drift over wide temperature range . . . two direct-coupled TE_{111} mode cylindrical cavities with single tuning control . . . counterdial and calibration chart or slotted shaft adjustment. Price: $398.00 each (less quantity discount).

Frequency Standard's 14 years of experience in the development and production of high performance microwave filters is available to you without obligation. Look into our capabilities for special preselectors with balanced mixer as well as low bandpass and band rejection filters for both high and low power applications. Write for Bulletin P-26102 or send specific bandwidth and other requirements to Department KF.

FREQUENCY STANDARDS

A DIVISION OF HARVARD INDUSTRIES, INC.
BOX 504 · ASBURY PARK, N. J. · PROSPECT 4-0500

Center for new ideas in microwave technology— Discriminators, Antenna Couplers, Diplexers, Wavemeters, Reference Cavities, Signal Sources, Directional Couplers, Antennas, Cavities

(*Continued from page 106*)

MELABS ADDS TO LINE OF LOW NOISE AMPLIFIERS

Melabs, Palo Alto, Cal., announces another new addition to its comprehensive line of low noise amplifiers. The model, X-217, has a noise figure of less than two db; in a typical application provides a seven db improvement when connected to an existing system having a nine db noise figure.

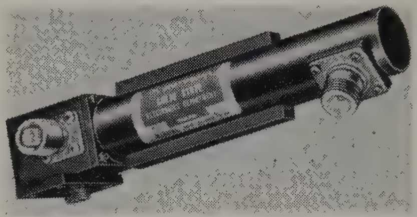
Operating range is 1220 to 1350 megacycles, tuning being accomplished with only a single control. Gain is a minimum of 20 db over a nominal bandwidth of 15 megacycles. The unit is a regenerative type with a pump frequency at 9750 megacycles.

Special features include exceptional stability under short circuit conditions or with any kind of mismatch at output or input. Use of a single Melabs 4-port ferrite circulator avoids the usual requirement for several separate circulators while providing essential input directivity and output isolation and an improvement in noise figure. The power supply section of this particular parametric amplifier incorporates a high degree of regulation which also contributes materially to overall stability.

Circle Reader Service Card 110

—*mwj*—

C-BAND CIRCULATOR AVAILABLE FROM MOTOROLA



The Motorola Solid State Electronics Department, Scottsdale, Ariz., has announced the availability of a new C-Band circulator. The light-weight, compact unit offers high performance over a wide temperature range with a broad frequency bandwidth.

Operating on the Faraday rotation principle, the model CC03 circulator is a multiport device that transmits a signal from one port to an adjacent port while decoupling the signal from all other ports.

With design based on a low-loss, high performance ferrite developed at Motorola, the device operates from 5400 - 5900 Mc with the transmitter-to-antenna and antenna-to-receiver insertion losses each less than 1.2 db. The antenna-to-transmitter isolation with the receiver shorted and the transmitter-to-receiver isolation are greater than 12 db over the frequency band at temperatures ranging from −55° to −105°C.

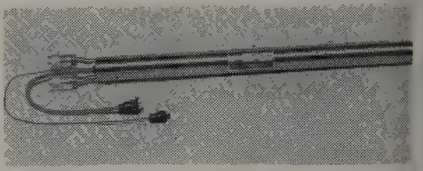
Circle Reader Service Card 111

—*mwj*—

HUGGINS OFFERS TWT WITH 5 DB NOISE FIGURE

Huggins Laboratories, Inc., Sunnyvale, Cal., has introduced the newly developed HA-89 low-noise traveling-wave tube amplifier.

This TWT exhibits less than five db noise across selected 400 Mc portions of the S-band while attaining greater than 25 db small-signal gain and 10 mw saturation output power. Operated broadband, 2.0 to 4.0 kMc, the HA-89 achieves eight db maximum noise figure, 20 db minimum small-signal gain, and greater than 10 mw saturation output power. This relatively high output power reduces troubles associated with inter-and cross-modulation effects when simultaneous reception of large and small signals is desired.

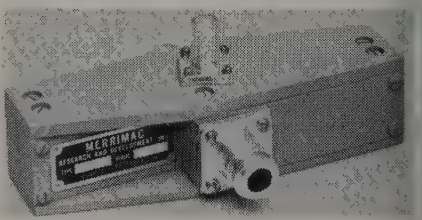


The HA-89 measures 19 7/8 inches long, including connectors, by 1 5/16 inches O.D. and weighs two lbs. 7 ounces. All RF and DC connections are located at one end of the tube. The associated focusing solenoid is lightweight, 21 pounds, and required solenoid power is 125 watts maximum.

Circle Reader Service Card 112

—*mwj*—

MERRIMAC OFFERS ELECTRONICALLY VARIABLE ATTENUATOR



Merrimac Research and Development, Inc., Irvington, N. J., announces an electronically controlled solid state variable attenuator, model AAE-1.

The unit is sweepable over a minimum of 15 db of attenuation range over the 200 to 600 Mc band, with flat attenuation vs. frequency characteristics. Initial loss is under two db at the band edges and

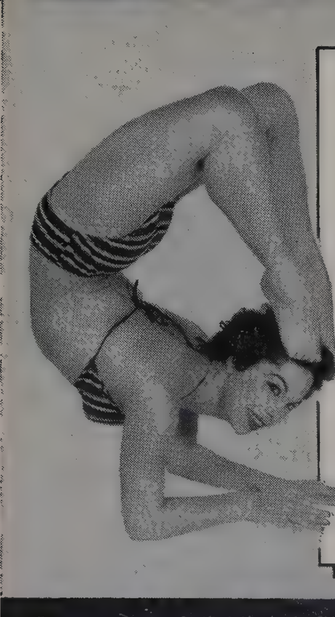
(*Continued on page 110*)

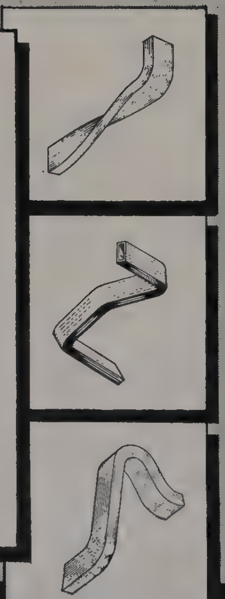
UNIWAVE GIVES YOU *MICROSMOOTH* BENDS AND TWISTS IN WAVEGUIDE

Uniwave's MICRO SMOOTH forming process for bending and twisting waveguides produces a uniformly smooth interior, devoid of energy absorbing "hot-spots". This MICRO SMOOTH process allows for closer tolerances to be held on inner diameters, and bends in any plane can be combined with tight radii. Draw marks, creases and ripples are eliminated, allowing for distortion-free wave travel. This process has been successfully used on all production and experimental band radar and microwave systems. Quotations can be furnished to customer's blueprints for all sizes, shapes, lengths and quantities.

UNIWAVE, INC.

MARINE STREET
FARMINGDALE, N. Y. · CHAPEL 9-8180-1





Circle Reader Service Card 65

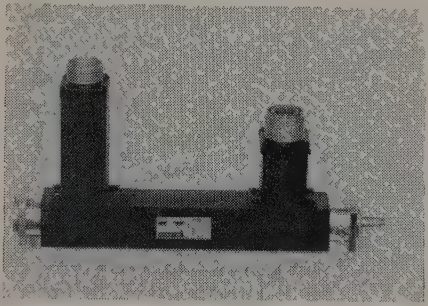
Protection Is Built Into Tucor Noise Sources

One problem faced by the designer of nodern high power radars is how to ouple sufficient noise power into his ntenna line to provide good performnce monitoring without "burning up" he noise source with the incident ower. Tucor has solved this problem y designing special TR tubes into their oise source mounts so as to protect the oise tube. This is one reason why ucor noise sources are unique in the nicrowave field where quality is critical et the package must be compact, ugged and able to withstand the stiffst military conditions.

As for the range of these high noiseutput tubes, the tabulation below gives ome idea of the wide variety of Tucor oise sources that are available from tock. Many additional tubes have been nade, and others are being designed to it special applications.

Tucor noise sources are small size, wide bandwidth devices designed to operate under typical military environmental conditions and capable of supplying a high noise output with negligible insertion loss in the unfired condition.

In our current catalogue, 32 noise sources presently in production are listed. Many more are available for virtually every system requirement. For your copy, circle the reader service card.



T44S11D

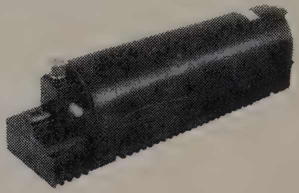
Band	Type	Freq. KMC	Noise DB	Oper. V	Oper. MA	Striking V
VHF	T44V1D	0.2-0.4	18.5	170	50	1100
UHF	T44U1D	0.4-1.0	18.5	120	40	950
L	T44L1D	1.0-2.0	18.5	200	50	1900
S	T44S11D	1.0-4.0	18.5	160	50	1900
C	T44C1A	5.3-6.0	18.5	60	150	700
H	T44H1A	7.5-8.6	18.5	40	75	750
X	T44X7B	8.2-12.4	18.5	90	75	1200
K	T44K1B	12.4-18.0	18.4	100	50	2000
P	T44P1B	18.0-26.0	18.0	60	50	1200
Q	T44Q1B	26.0-40.0	18.5	35	60	1200

TUCOR BWO'S ATTAIN EXTREME STATE OF ART IN SPECTRAL PURITY

A special hollow-beam gun in a solenoid-focussed tube provides Tucor backward wave oscillators with a unique degree of spectral purity and non-microphonic response. Tucor BWO's, of which models are available for the handling of frequencies from 3 through 14 Kmc, retain this purity through conditions of extreme shock, vibration, temperature and humidity.

Designed expressly for systems requiring Doppler information, these tubes are completely encapsulated with an integral heat sink. This design provides an extremely stable frequency output, as well as one of the narrowest spectra of any generators over a wide tuning range.

Low noise output is another feature of Tucor BWO's, which, like all Tucor tubes, are highly processed to provide extra dependability under adverse conditions.



T15C1C

TUCOR SERVICES FOR SPECIAL PROBLEMS

By Roger E. White, president of Tucor, Inc.

For more than 10 years, key staff members of this company have solved problems of injecting noise into microwave systems for performance-monitoring purposes, at virtually every frequency, power level and physical configuration.

If your problem in this field requires our kind of experience, please contact me personally. The long distance telephone, the mails, and a twin engine plane insure that solutions can be arrived at quickly and with utmost convenience to you.

TUCOR
INC.

59 Danbury Road (Route 7), Wilton, Connecticut

Circle Reader Service Card 66

New Products

(*Continued from page 108*)

under one db at band center, and VSWR is under 1.7:1 at band edges and under 1.4:1 at band center. Small, 3.25 inches long from input to output, the attenuator requires only a few milliwatts of bias power.

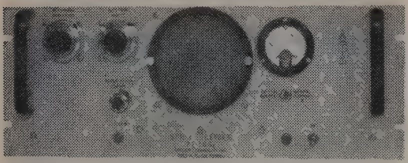
Although the characteristics are sensitive to RF power level, above 10 mw average, the attenuator does perform at levels up to 500 mw average. For applications where RF power is higher than 150 mw average, a special triggering circuit can be provided which makes the circuit self-biasing.

A few of the many possible applications are: sweepable attenuator, modulator, sensitivity time control for radar equipment.

Circle Reader Service Card 113

—*mwj*—

TUNABLE S-BAND RECEIVER FEATURES HIGH SELECTIVITY



Applied Technology, Inc., Palo Alto, Cal., has introduced the Model STR-1 Receiver. The Model STR-1 is tunable from 2.7 Gc to 3.0 Gc and has a tangential sensitivity of —93 dbm.

A flat, 10 Mc wide RF passband, established by a three-cavity preselector, makes tuning relatively uncritical, while the off-frequency signal rejection allows the receiver to be diplexed with transmitting equipment operating a few tens of megacycles away. Principal applications of the receiver are in RF data link systems or similar systems where transmission and reception at nearby frequencies are employed.

This receiver has an intermediate frequency of 30 Mc and an IF bandwidth of two Mc. Image rejection is better than 60 db. The video section of the receiver has a bandwidth of one Mc and features four individual outputs for use with 93 ohm cable. The receiver is intended for use with a 50 ohm source.

Operating controls include Preselector Tuning, Klystron Cavity, Klystron Reflector, and IF Gain. The unit is intended for rack mounting, occupying 5 1/4 inches of panel height and 15 inches of chassis depth. Power required is 109 to 121 volts, 60 cps, single phase, at two amperes.

The standard model is priced at $5500, F.O.B. Palo Alto with delivery in ninety days.

Circle Reader Service Card 114

—*mwj*—

SYLVANIA FERRITE CIRCULATORS OPERATE OVER WIDER TEMPERATURE RANGE

The availability of three-port ferrite circulators operating from —30 to +70 degrees Centigrade without temperature compensation has been announced by Sylvania Electric Products Inc.

Designed principally for applications in common carrier and industrial communications, the new circulators are fitted with RG-50, RG-51, RG-52, or WR-75 waveguide for maximum utility. Units are available in versions covering the following frequency bands: 5.4 to 5.9 Gc, 5.925 to 6.425 Gc, 6.575 to 7.124 Gc, 10.7 to 11.7 Gc, and 12.2 to 12.7 Gc, according to Richard A. Stonesifer, product sales manager of Sylvania's Microwave Device Operations, Mountain View, Cal.

The devices offer 20 db minimum isolation, 0.5 db maximum insertion loss, and 1.2 to 1 maximum VSWR, and will withstand up to 10 watts CW or average power, Mr. Stonesifer said. In addition, they maintain all electrical characteristics over the full temperature range, making them effective over a spread of 100 Centigrade degrees.

Mr. Stonesifer said units are available in 45 to 60 days. By September 1, delivery can be made in 30 to 45 days.

Circle Reader Service Card 115

—*mwj*—

DIRECT-READING WAVEMETER PROVIDES HIGH ACCURACY WITHOUT CHARTS

New Data-Dial (patented) direct-reading wavemeters, which provide high accuracy of direct frequency readout over the entire range of the instrument without requiring correction tables or charts to compensate for residual non-linearity, are announced by General Communication Co., Boston, Mass.

The frequency scale is a slightly sloping line on a long tape, which moves behind a window on which a curved index line is drawn. As the cavity is tuned through its range, the intersection of these two curves shifts by exactly the amount needed to offset residual variations over the band covered, giving the frequency at any setting without further correction.

MEGACYCLES
General Communication Company

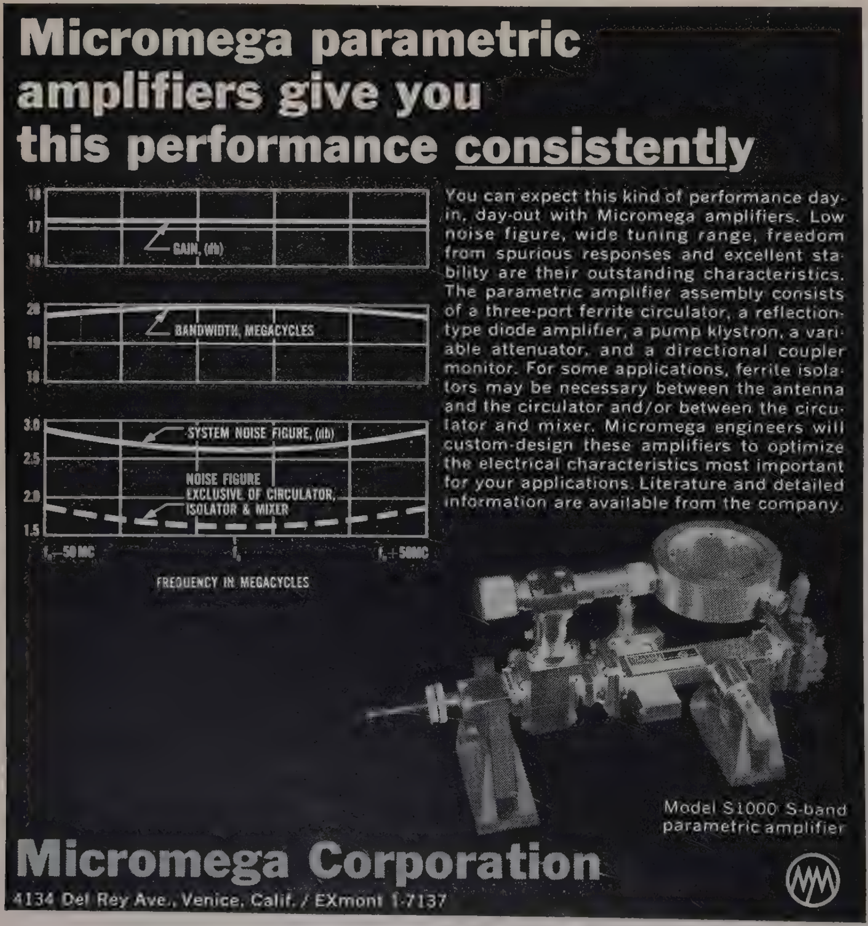
Model 3102 covers frequencies from 900 to 2100 Mc, with integral crystal detector output. Model 3103, in final development, will cover from 2350 to 3750 Mc.

Other models will extend the range of this new line to additional bands.

Circle Reader Service Card 116

—*mwj*—

(*Continued on page 112*)

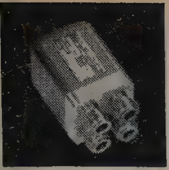

Micromega parametric amplifiers give you this performance consistently

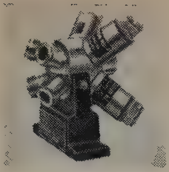
You can expect this kind of performance day-in, day-out with Micromega amplifiers. Low noise figure, wide tuning range, freedom from spurious responses and excellent stability are their outstanding characteristics. The parametric amplifier assembly consists of a three-port ferrite circulator, a reflection-type diode amplifier, a pump klystron, a variable attenuator, and a directional coupler monitor. For some applications, ferrite isolators may be necessary between the antenna and the circulator and/or between the circulator and mixer. Micromega engineers will custom-design these amplifiers to optimize the electrical characteristics most important for your applications. Literature and detailed information are available from the company.

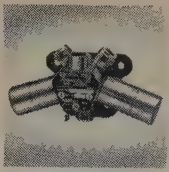
Model S1000 S-band parametric amplifier

Micromega Corporation
4134 Del Rey Ave., Venice, Calif. / EXmont 1-7137

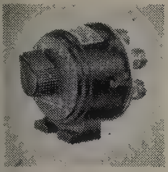
Circle Reader Service Card 68

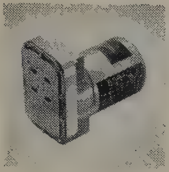

WT-TYPE

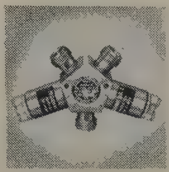

A-TYPE

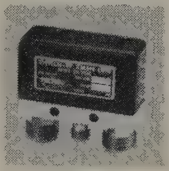

Y-LATCH

TRANSPROBE

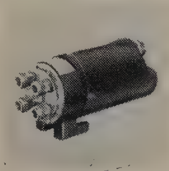

M-TYPE


TRANSFER


Y-TYPE


W-TYPE

TX PROBE


E-TYPE

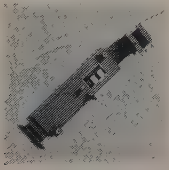
YL-TYPE

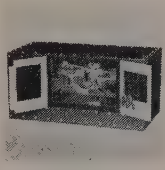
L-TYPE

MICROWAVE SWITCHES

WT-TYPE coaxial transfer switch, N & TNC connectors, single solenoid, 115 VAC (28 VDC @ .6 amps), 10 oz., typical spec.: 0-6 KMC, VSWR 1.4, I.L. 0.3db, crosstalk 25db. **A-TYPE** coaxial SP4T (SP3T) switch, N connectors, 28 VDC (115 VAC), each solenoid 6 watts, normally open or closed, 12 oz., 0-11 KMC typical spec. at 7 KMC: VSWR 1.2, I.L. 0.2db, crosstalk 35db. **Y-LATCH** SPDT coaxial latching switch, N & TNC connectors, 3 amps peak @ 28 VDC, switching time 10ms, no holding power required, life 1,000,000 oper., 8.5 oz., spec. same as Y-type. **TRANSPROBE** SP2T (SP3T) waveguide switch, X Band, .7 amps @ 28 VDC (115 VAC), 6 oz., full waveguide power, typical spec.: 8.2-12.4 KMC, VSWR 1.20, I.L. 0.2db, crosstalk 35db. **M-TYPE** SP2T to SP6T, DPDT, transfer, manual coaxial switch, N connectors, shelf or panel mount, 1.2 to 1.6 lbs., 0-11 KMC, typical spec. at 7 KMC: VSWR 1.2 I.L. 0.3, crosstalk 60db. **TRANSFER** waveguide switch, X & K-Band motor actuated, .25 amps @ 28 VDC, typical spec. for K-Band: 18-26 KMC, VSWR 1.05, I.L. .07db, crosstalk 80db, 2.5 lb. **Y-TYPE** SP2T (SPST) coaxial switch, N, HN, C, TNC, BNC connectors, 28 VDC (115 VAC), each solenoid 6 watts normally open or closed, 6 oz., 0-11 KMC, typical spec. at 7 KMC: VSWR 1.1, I.L. 0.2, crosstalk 35db. **W-TYPE** SP2T coaxial latching switch, N, HN, TNC connectors, 28 VDC (115 VAC), 2 amps peak @ 28 VDC, switching time 10ms, 6 oz., 0-6 KMC, typical spec.: VSWR 1.4, I.L. 0.3db, crosstalk 25db. **TX PROBE** transprobe waveguide transfer switch, demonstrates the flexibility of the design. Adapts readily to SP3T or multipole switching. **E-TYPE** SP2T to SP6T, DPDT, transfer, motor actuated coaxial switch, N, TNC connectors, 28 VDC (115 VAC), 2.3 to 2.9 lbs., 0-11 KMC, spec. at 7 KMC: VSWR 1.2, I.L. 0.3db, crosstalk 60db. **YL-TYPE** SPDT coaxial switch, LT, LN connectors, .5 amps @ 28 VDC, each solenoid normally open or closed, 3 lb., 5000 watts R.F., typical spec. at 5 KMC: VSWR 1.35, I.L. 0.4db, crosstalk 30db. **L-TYPE** SA-498 coaxial lobing switch, 950-1250 MC, N, HN connectors, switching rate 17-35 cps, 21 oz., MIL-S-25568, spec.: VSWR 1.3, I.L. 0.4db, crosstalk 40db.

DIVIDERS


COUPLERS

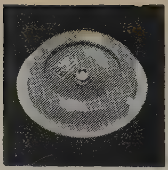

DELAY

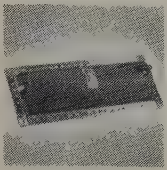
ATTENUATORS

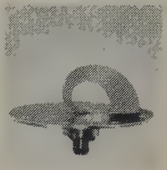
MICROWAVE COMPONENTS

DIVIDERS coaxial and waveguide power dividers, L, S, C, & X-Bands, 2 & 3 way even, 50 ohm, VSWR 1.3:1, 2.5-4 oz. **COUPLERS,** coaxial directional couplers; shown in 54db, S-Band high power directional coupler, 5 megawatt peak power. **DELAY** line, K-Band, non-loaded waveguide type, power 30 KW, 10 x 10 x 30 in., remotely selects 2 delays. (An example of Transco's sub-system capability) **ATTENUATORS,** coaxial and waveguide; shown is C-Band, motor actuated 0-100db in 50 sec., 0.1db or 1% accuracy at calibration freq.

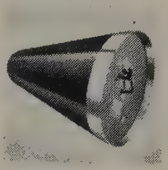
AT-741

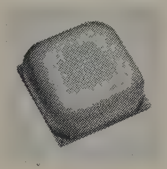

AT-740

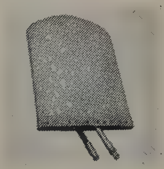

BEACON

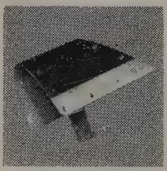

SCIMITAR

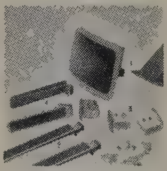
DATA LINK


TELEMETRY


E.C.M.


UHF/L


HORN


BALLISTIC

MICROWAVE ANTENNAS

AT-741 antenna, part no. 2335, L-Band, MIL-A-25708, for IFF and/or TACAN, 6.4 oz., spec.: 50 ohm, 960-1220 MC, VSWR, 1.5 1000 to 1100 MC, vert. pol. **AT-740** antenna, part no. 22135, L-Band, MIL-A-6543, for IFF and/or TACAN, 12 oz., spec.: 50 ohm, 960-1220 MC, VSWR 1.5 1000-1200 MC, vert. pol. **BEACON** antenna (75 MC marker beacon), tuned flush stub, approx. 5 x 12 x 2 in., 25 oz., spec.: 50 ohm, horiz. pol., bandwidth 300 KC, VSWR 1.5. **SCIMITAR** antennas, P-Band receiving, L&S-Band transmitting—VSWR 1.25, power 800 watts CW, for supersonic aircraft. **DATA LINK** antenna, dual pattern, self-contained coaxial switch—power divider-phasing network, 225-400 MC, VSWR 2.5 omni pattern, 1.4 cardioid pattern. **TELEMETRY** antenna, 225-260 MC, balun supported bent dipole, 50 ohm, VSWR 2:1, circular pol. **E.C.M.** multiple helix transmitting antenna, omni directional, 950-1550 MC, 1475-2350 MC, 2300-3600 MC, 3475-5000 MC, 500 watts CW, VSWR 1.7. **UHF/L** band antenna, 225-400 MC & 960-1220 MC, 50 ohms, VSWR 2:1 UHF & 1.8:1 L-Band, vert. pol., 25 & 60db isolation, omni directional. **HORN** X-Band waveguide horn antennas, 5.5-11 KMC, VSWR 1.5, circular pol., peak power 50 KW, 1 lb. **BALLISTIC** missile antennas, doppler, telemetry, range safety, azusa, and beacon; HF thru C-Band.

TRANSCO

TRANSCO PRODUCTS, INC.
12210 Nebraska Avenue, Los Angeles 25, California

WRITE FOR CATALOG
Transco Application
Engineers and
Representatives
Throughout the United
States and Canada

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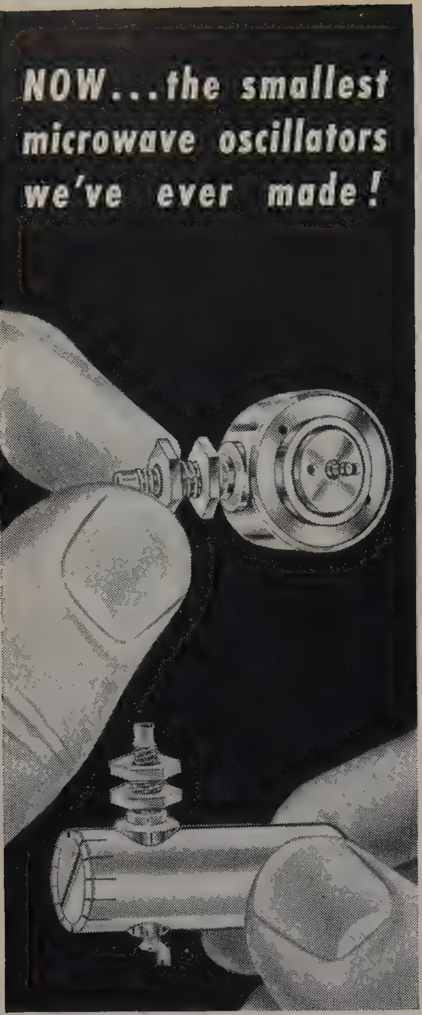


Microwave projects, impossible before, are now possible with these new sub-miniature Trak microwave oscillators. Limited quantities of developmental models now available.

TRAK TYPE 9180 Size: ⅜" long by ¾" diameter, excluding projections. Frequency: plate pulse, 4.5 KMc to 6 KMc; CW service, 4.0 to 5.5 KMc. Tuning range is limited to approximately 100 megacycles.

TRAK TYPE 9181 Size: 1½" long by 9/16" diameter, excluding projections. Frequency: CW service, 5.0 KMc to 6.0 KMc with tentative tuning range of 400 megacycles.

TRAK MICROWAVE offers a complete line of microwave energy sources including oscillators, amplifiers and harmonic generators. Write for Catalog 61-A.
See our WESCON display — Booth 2117; ISA display — Booth 501.

TRAK Microwave
TRAK MICROWAVE CORPORATION
5006 N. Coolidge Avenue
Tampa 3, Florida
PHONE: REdwood 6-6422 or REdwood 6-6407

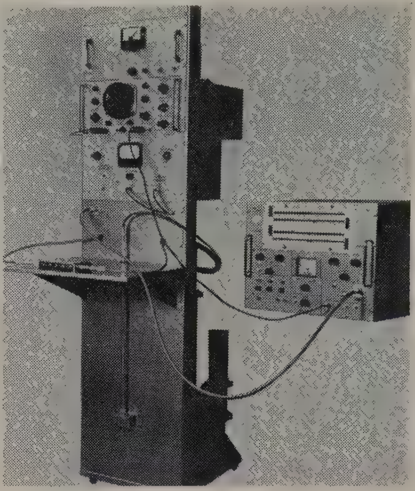
Specialists In Miniature Microwave Energy Sources

Circle Reader Service Card 70

New Products

(*Continued from page 110*)

RANTEC OFFERS PRECISION PHASE MEASUREMENT CONSOLE



Rantec Corp., Calabasas, Cal., announces a new precision phase measurement system for microwave frequencies. The model ETS-10 system for the 3000 Mc band is capable of measurement resolution and repeatibility to 0.1 degrees. The system utilizes a ferrite modulator technique and a phase discriminator circuit.

Advantages of system are: easy to set up and calibrate; readings are not affected by amplitude of input signal or variations in insertion loss of unit under test; readout can be (a) calibrated meter, (b) swept oscilloscope display of phase shift vs. frequency, (c) recorded plot.

Modern demands on pulse transmission fidelity has increased the importance of linear-phase, or constant-time-delay, response of microwave components such as filters. The oscilloscope presentation has been found particularly useful and convenient for the final adjustment of linear-phase filters.

Circle Reader Service Card 117

—mwj—

VERSATILE SCOPE DOLLY AVAILABLE FROM METAL DYNAMICS

Now being produced by Metal Dynamics Corp., Philadelphia, Pa., is the new model #61056 Scope Dolly, a low-cost unit specially produced for laboratory and shop applications.

One of the many features includes three convenient power outlets and one input. In addition, a storage area is provided for spare preamplifiers plus a roomy storage pan for accessories such as powe cord, tools, manuals, etc.

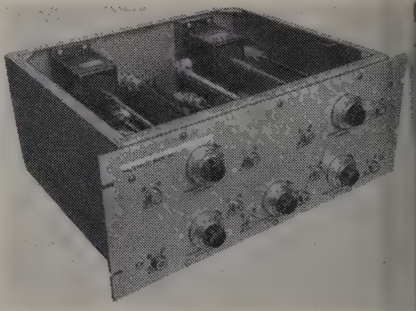
Special operational designs include 20 degree viewing angle to accommodat any popular type laboratory scope. Casters are five inches diameter ball bearin swivel type with semi-hard rubber wheel. Another feature is the protective rubbe gasket which prevents damage to th scope while installing or removing.

Model #61056 is equipped with ad justable brackets to accommodate an popular type laboratory scope. Simple relocation permits range of adjustmen from six to 12 3/4 inches wide, to 16 1/ to 22 1/2 inches long. The scope doll is easy to assemble, and is constructed c cold rolled steel with gray baked ename finish, which meets MIL specification It is priced at $59.95.

Circle Reader Service Card 118

—mwj—

SERIES OF TUNABLE FILTERS OFFERED BY FREQUENCY STANDARDS



Accurate measurement of frequenci in the S-, C- and X-Bands is readily obtainable with a new panel-mounted uni incorporating a series of tunable bandpa filters from Frequency Standards, Asbur Park, N. J.

Insertion loss of the tunable filter i each of the bands (including a low pa filter, bandpass filter adapters and inte connecting line) is less than five db average. Absolute accuracy of the calibrate frequency is ± 0.01 per cent. Bandwidt at 11 and nine Mcs is three db down an 0.25 db down respectively. Spurious re sponses are eliminated by a low pass filte and tuning is achieved by a single duo-dia counter. The frequency point is centere in the passband to an accuracy of ±5 pe cent of the three db bandwidth.

Each filter is terminated in a thermisto for spectrum power measurements. Stand ard Type N female connectors are use except for a UG 39/U flange which i used in the X-Band output. Both outpu connectors are extended to the front o the panel.

Circle Reader Service Card 119

—mwj—

(*Continued on page 114*)

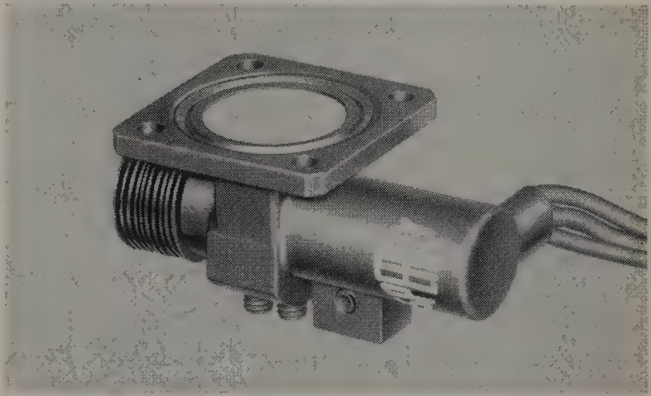
nother
microwave memo
from SPERRY ELECTRONIC TUBE DIVISION

Announcing 30-Day Delivery on U Band, Two-Cavity Oscillators For Parametric Amplifier Pumping

perry Electronic Tube Division, Gainesville, Florida, nnounces an *immediate* solution to the drive source probms which have plagued developers of parametric amplirs for some time. Now Sperry can deliver a U band, o-cavity klystron oscillator in just 30 days.

Fast delivery is possible because development work completed on all tubes within the frequency and power tput parameters described below. Soundness of the delopment work is already proved, since tubes of this pe have been operating in several systems for some time.

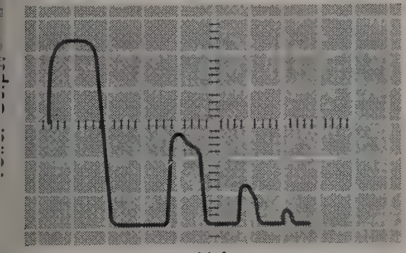
Sperry has developed a whole family of these ositors. They cover the entire U band, and deliver output wers from 200 mW to 1.5 W.



PPLICATIONS

ll tubes in the new Sperry family erate with a characteristic flatp mode. This constant relationip between beam voltage and outut power makes tubes in the series articularly suited for driving paraetric amplifiers, and for use in oppler radars and FM communiation systems.

One important benefit of the at-top mode characteristic is the vailability of frequency modulation ith very low incidental amplitude odulation. This inherent amplitude ability, together with high power utput levels, makes the new oscilator family particularly useful for arametric amplifier applications. he same characteristics contribute the desirability of these tubes for se in doppler radars and FM ommunication systems.



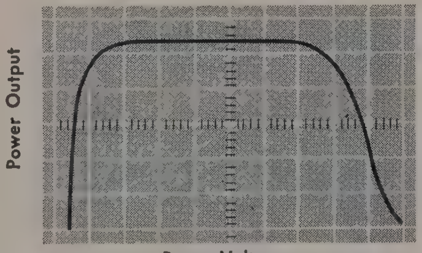
ypical mode shapes of two-cavity oscillator.

RATINGS

wo-cavity oscillators in the Sperry eries completely blanket the 12.5 o 18 kMc frequency range covered y the U band. The "family" of tubes is divided into two branches, one ranging from 12.5 to 15.5 kMc, and the other covering the 15.5 to 18 kMc area.

Output power ranges from 200 mW to 1.5 W in the lower frequency group, and from 200 mW to 1 W at the higher frequencies.

If optimum tuned, rather than flat-top mode operation is desired, power output may be increased 25%.



A typical main mode, adjusted for optimum flat-top operation.

INHERENT BENEFITS

Tubes in the new Sperry family enjoy all the inherent benefits of two-cavity klystron design. These include precision tuning, high stability, amazing ruggedness and unusual stability at high output levels.

The series incorporates two design features which result in significant size and weight savings.

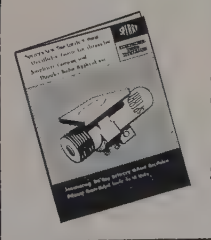
1. Electrostatic focusing, eliminating the heavy focusing magnets required in many designs.

2. A unique fixed-tuned design, in which the cavities are pressed into a configuration which delivers the customer's specified frequency.

All the tubes in this series show efficiencies in the area of 3.4% with the flat-top mode, and all have low levels of vibration-induced AM and FM noise.

PRICE AND AVAILABILITY

At power output levels from 0.2 to 0.5 watts, tubes in the new Sperry family are priced at $2,295 each. With output from .5 to 1.5 watts, the price is $2,795 each. Tubes will be tuned to your specified center frequency, and they will deliver your specified power output level. All oscillators in this U band series will be shipped within thirty days of receipt of order.



WRITE FOR SPERRY'S NEW BROCHURE which describes the new U band oscillator family in greater detail. For the brochure, or for application assistance and quotation, contact:

R. F. Forlaw, Section 601
Sperry Electronic Tube Division
Sperry Rand Corporation, Gainesville, Fla.

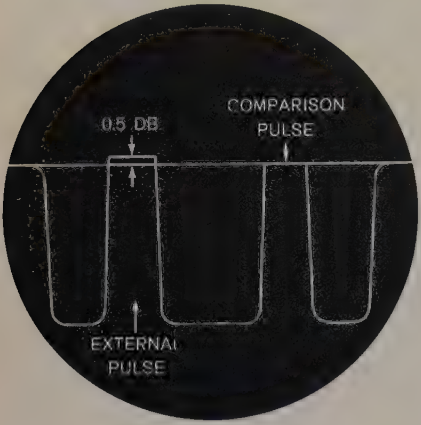
SPERRY ELECTRONIC TUBE DIVISION
GAINESVILLE, FLORIDA • GREAT NECK, N. Y.

SPERRY ELECTRONIC TUBE DIVISION

Circle Reader Service Card 71

DETERMINE

PEAK PULSE POWER WITHIN 0.5 DB



WITH MULTI-BAND FLEXIBILITY

The Series 5000 Pulse Power Calibrator is the only instrument that will give a final, direct reading of peak rf pulse power to this degree of accuracy . . . quickly, regardless of waveshape, and without introducing unknown errors. In addition, it provides multiple-band coverage, through the use of interchangeable rf heads.

RF Unit Model 5205, now available, covers the range from 8500 to 9600 mc. Other rf heads, in development, will cover further important bands. The display, essentially a notch wattmeter, permits comparative power discrimination within less than 0.1 db. Direct input power level range is approximately −5 to +63 dbm.

WRITE TODAY for more information on this and other new GCC developments in microwave components, wavemeters, attenuators, oscillators and test equipment.

GENERAL COMMUNICATION COMPANY

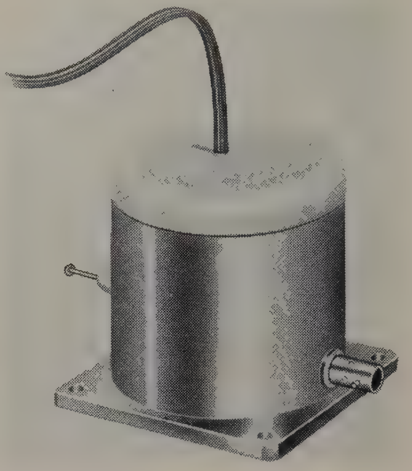
677 Beacon Street
Boston, Mass.

Circle Reader Service Card 72

New Products

(*Continued from page 112*)

S-BAND FLOATING DRIFT TUBE KLYSTRONS DEVELOPED



The Tube Division of Lewis and Kaufman Electronics Corp., Los Gatos, Cal., has developed and now has available a family of five floating drift tube klystrons to operate within S-Band frequencies (2.6 to 3.95 kMc).

The entire family of klystrons has identical outside configurations, with power ratings ranging from one to 50 watts. The tubes are all single-cavity oscillator type, employing a "one way" electron beam which eliminates hysteresis problems common to reflex type klystrons. The electron beam does not return to the cathode, eliminating mechanical and thermal damage and greatly increasing tube life.

The klystrons are supplied to operate at any prescribed, fixed S-Band frequency, and may be mounted in any position. The primary electrical characteristics of this klystron family are: Power outputs of 1, 5, 10, 25, and 50 watts/frequency, 2.6 to 3.95 kMc/efficiency, seven to 12 per cent, depending upon desired operating mode. Physical characteristics: Overall height, 3.5 inches; weight, 16 ounces maximum. Cooling is through conduction to heat sink, or forced air.

Featuring high efficiency, no magnetic requirement and light weight, these klystrons are ideally suited to telemetering, relay links, doppler radar and navigation applications.

Circle Reader Service Card 120

—*mwj*—

MOTOROLA ANNOUNCES FAMILY OF BROADBAND, WAVEGUIDE FERRITE ISOLATORS

Three new compact waveguide isolators are now available from the Motorola Solid State Electronics Department, Scottsdale, Ariz., for use at J-Band (5.850 - 8.200 kMc), X_N Band (8.200 - 12.400 kMc) and X_L Band (7.050 - 10.000 kMc).

The new Motorola devices are transverse field, resonance absorption isolators, each designed to maximize load isolation, maintain low insertion loss, and hold VSWR to a low level.

Designated Models J103, X103, and XL102, respectively, the J-Band, X_N-Band and X_L-Band isolators exhibit typical performance characteristics of 30 db minimum isolation, 1.0 db insertion loss, and 1.15 maximum VSWR over the specified operating frequency band.

The isolators are three of a series of broadband, waveguide units specifically designed for inclusion in microwave measurement set-ups, where they can be used effectively in isolating generators from load effects, avoiding frequency pulling and guarding against erroneous measurements. They find additional application in low power set-ups where maintenance of signal source stability or elimination of long line effects is desired.

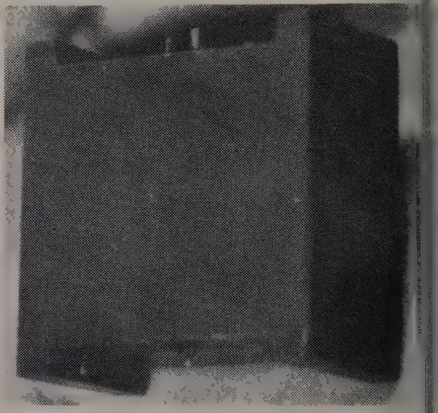
Circle Reader Service Card 121

—*mwj*—

"THOR" POWER METER ANNOUNCED BY UNILECTRON

The "Thor" Power Meter, designed to measure continuously, by means of radio-telemetry, readings of shaft horsepower, has been announced by Unilectron, Inc., Cambridge, Mass.

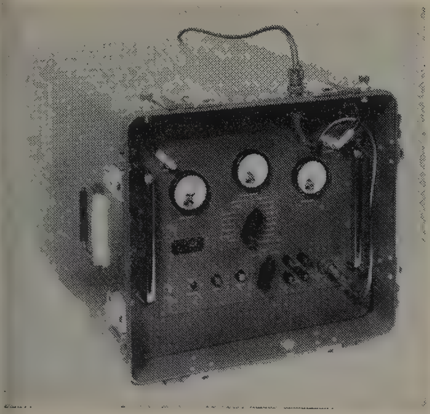
The "Thor" unit is mounted directly on the shaft and transmits readings to a remote location without wires, slip rings or other physical connections between rotating equipment and other stationary equipment. The unit weighs only 3 1/2 pounds, requires no maintenance and costs little to operate. Horsepower readings are extremely accurate (within one per cent). Thor utilizes a miniature FM/FM transmitter for noise-free operation and complete, solid-state electronics for the radio-telemetry portion of the system.



The electronically sensed torque-and-rpm signals are mixed and amplified. This intelligence is then used to cause a frequency deviation of a sub-carrier oscillator. The output from this oscillator is fed to a frequency modulated transmitter and then to the antenna. The signal is received by a VHF-FM receiver. It is then discriminated to obtain the sub-carrier frequency and discriminated again to produce an output signal proportional to frequency deviation. The output signal

(*Continued on page 116*)

UHF to VHF Converter



Unit is designed to allow change-over of existing VHF installations to UHF telemetry frequencies with a minimum of new equipment. Without tuning, this unit will convert any 2200 to 2300 mc signal to VHF for standard telemetry receivers. Noise is comparable with narrow band equipment. A 13 db gain prevents deterioration of signal-to-noise ratio. Rated for continuous operation in Mil Spec environments.

Microdot Inc., 220 Pasadena Avenue, South Pasadena, California

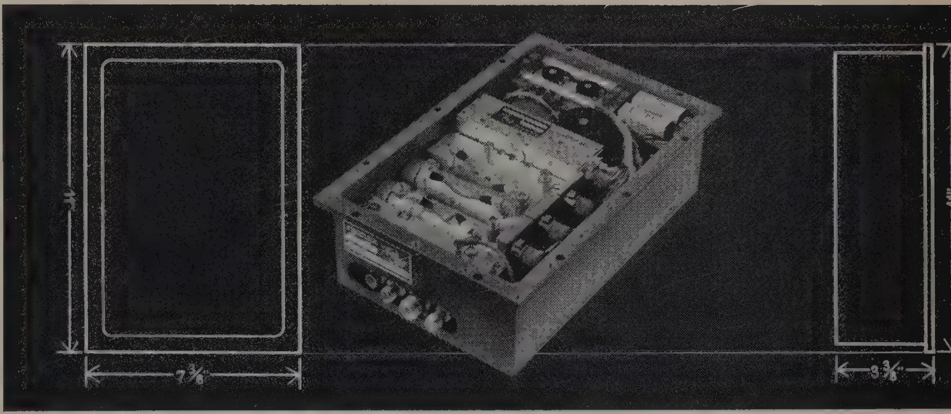
Circle Reader Service Card 73

Power Oscillator

These precision units are designed for laboratory use in the evaluation of antennas, calibration power measuring devices, driving of amplifiers, and other applications where higher power ratings are required. Model 410, shown above, offers a frequency range of 500 to 1050 mc direct reading. Power range is 50 mw to 50 w. The unit measures 8″ x 11½″ x 19″ and weighs 45 pounds. Other models cover ranges from 200-550 mc. All components are conservatively rated and carefully arranged for long life and convenient inspection.

Microdot Inc., 220 Pasadena Avenue, South Pasadena, California

Circle Reader Service Card 74



VHF-UHF TRANSMITTERS

Proved in history's most demanding environmental laboratory — outer space — the custom designed unit shown above is typical of the development skill and production capability available from Microdot. The unit shown in miniaturized, pressurized, and features a solid state power supply that cannot be damaged by input/output overloads. Units are available in a complete range of modulation — CW, FM, Phase, and Pulse, with frequency coverage 100 to 5000 mc/s and output from 100 mw to 10 watts.

Telemetry Capabilities at Microdot have been dramatically expanded with the recent acquisition of Spectralab Instrument Company. The highly regarded development skill, production capability, and working experience of Spectralab in the field o VHF and UHF cavities and related instrumentation is available from Microdot's Instrumentation Division. This equipment, outstanding in its attention to miniaturization and ruggedness, is a vital part of such important projects as Pioneer V, Jupiter Atlas, Pershing, Redstone and Echo I.

UHF Telemetry Transmitters, Models 2406 and 2409, use a unique, automatically stabilized circuit, with the output frequency referenced directly to a quartz crystal. This approach allows a greatly reduced size compared to the multiplier chain conventionally required to achieve crystal stability, as well as increased reliability due to a fewer number of parts.

The transmitters have their own solid state power supply designed to provide a high ratio of rf output power to total power input. The frequency modulation circuitry is sufficiently linear to introduce completely negligible distortion to the modulation signal. For further information, Call Microdot or write for catalog sheet TT-1.

SPECIFICATIONS

Frequency Range:	
Model 2406	2200-2300 mc/s
Model 2409	1435-1535 mc/s
Frequency Stability:	±0.001%
Power Output:	10 watts
Power Output Stability:	1 db
Modulation:	PCM/FM, PAM/FM, FM/FM
Input Voltage:	28 vdc
Temperature Range:	−40°C to +70°C
Vibration:	10 g, 5-2000 cps
Size:	3⅜″ x 7⅜″ x 11″
Weight:	12 pounds

MICRODOT INC
220 Pasadena Avenue, South Pasadena, Cal
MUrray 2-3351 SYcamore 9-9171

New Products

(*Continued from page 114*)

is amplified and applied to the read-out recorder.

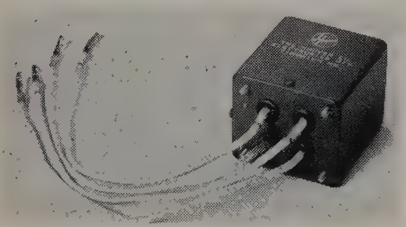
The speed, size and location of the shaft determines the basic packaging concept for a particular application. A typical installation on a ship propeller shaft, for example, would fit into less than six inches of actual space. The shaft portion of the instrumentation would weigh less than five pounds.

A "Thor", three-channel system is also available if a separate and direct indication of torque and rpm is desired.

Circle Reader Service Card 122

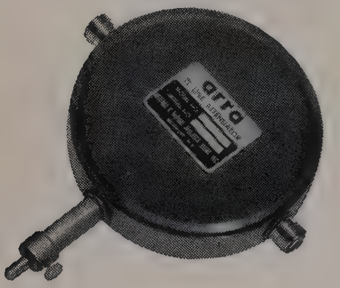
—*mwj*—

HOOVER ANNOUNCES HIGH EFFICIENCY POWER CONVERTERS



The Hoover Company, Electronics Division, Baltimore, Md., has recently announced a new line of power converters featuring a significant improvement in conversion efficiency.

arra π LINE CONTINUOUSLY VARIABLE ATTENUATOR



Exclusive Features:

- Broadband Impedance Match.
- Min. VSWR for all values of attenuation over band.
- Insertion Loss: 0.2 db max.
- Drive: Shaft drives for systems & power level applications.
- Connectors: Type "N" Female (others on request).
- Size: 5" dia. x 1" high, excluding connectors and micrometer.
- Power Rating: 10 watts average min.
- Continuously variable for all values of attenuation.
- Write for Information — Dept. P-IRE

arra Antenna & Radome Research Associates
27 BOND STREET • WESTBURY, N. Y.

Circle Reader Service Card 76

Mr. A. J. W. Novak, General Manager of the Division, described the new converters as being ideally suited for applications where the power source is a thermoelectric generator, fuel cell, or low voltage battery. The efficiency of the new unit is greater than 75 per cent.

A wide range of input and output parameters is available. Complete solid state construction eliminates maintenance considerations. Typical applications include battery-charging equipment for radio and radar beacons, signal buoys at sea, space platforms, microwave link stations, vehicle-mounted equipment, and standby power sources in general. The improved efficiency of this new device will make possible many applications that were previously regarded as impractical.

Converters with an input as low as 0.1 volt are practical. Virtually any output, either ac or dc, can be supplied. The units designed for battery-charging applications will not discharge the battery when the power source is disconnected or operating at low power.

Circle Reader Service Card 123

—*mwj*—

LUMATRON ANNOUNCES BANDPASS SAMPLING OSCILLOSCOPE

Lumatron Electronics, Inc., New Hyde Park, L. I., N. Y., has announced a new, ultra high speed sampling oscilloscope, the Model 112A Extended Bandpass Sampling Oscilloscope.

With a risetime of less than 0.2 ns, the Model 112A has an equivalent bandpass of approximately two kMc (six db down) and 1.7 kMc (three db down). In addition to this extended bandpass, the Model 112A offers extreme sensitivity — better than 3.0 mv/cm, low noise — less than 600 uv, and sweep rates to 0.05 ns/cm. The instrument uses new "state of the art" techniques in the sampling section to achieve its performance.

The 112A permits the accurate display of waveforms previously too fast for existing conventional and sampling oscilloscopes. It is now possible, for example, to observe kilomegacycle ringing and other ultra-high frequency waveform anomalies which can prove so troublesome to circuit designers. Also, switching characteristics of some of the new extremely fast semiconductor devices such as tunnel diodes and parametric amplifiers can now be observed and studied with ease.

The basic Model 112A is a complete instrument, ready to operate with either its own built-in delay line, or an external extended bandpass delay line. A number of options are available as built-in features including dual channel inputs, dc coupled inputs, camera controls, step attenuator and X-Y recorder outputs.

Circle Reader Service Card 124

—*mwj*—

7.5 KW PULSE TUBE WARRANTED FOR 2500 HOURS

The Amperex type 7899, a forced air cooled triode designed for pulse operation as a hard tube modulator or pulsed RF amplifier, and warranted for 2500 hours, has been announced by Amperex Electronic Corp., Hicksville, N. Y.

The tube is suitable for high reliability pulsing of radar, loran, or other navigational or tracking systems. The cathode has been designed to provide especially high peak currents. This measurably lengthens tube life and permits the warranty to be extended to 2500 hours under permissible ratings and duty factors. The tube has been thoroughly field tested in important loran transmitters with excellent results.

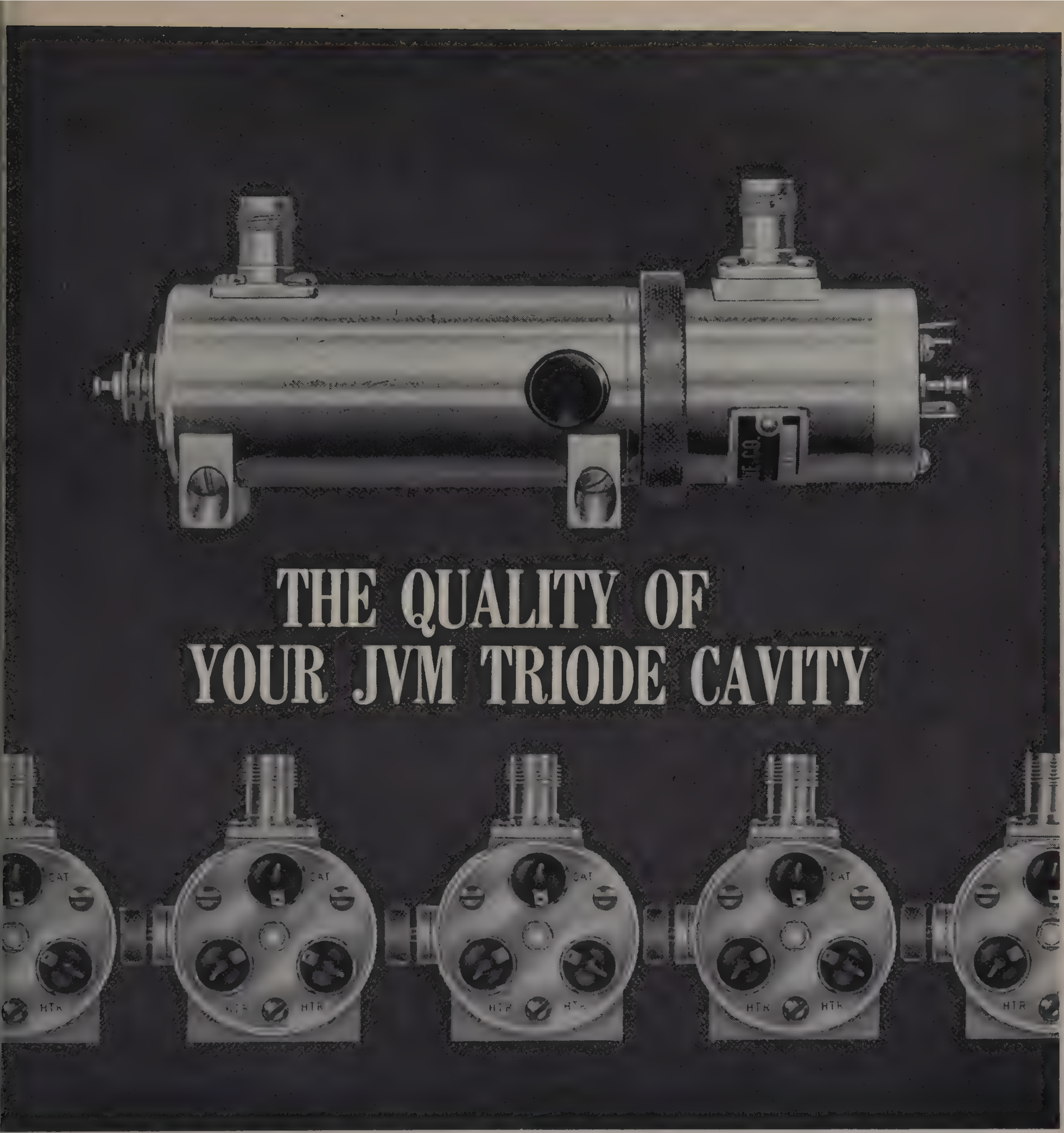
Ratings are: filament voltage — 8 volts; plate dissipation — 7.5 kw; filament current (8 v.) — 130 amps; amplification factor — 33; transconductance — 25,000 μmhos; dc plate voltage — 20,000 volts max.; peak plate current — 85 amps max.; peak cathode current — 100 amps max.; and duty factor — 0.025.

This basic type is also manufactured for CW operation under type No. 7800; Dissipation 15 kw.

Circle Reader Service Card 125

—*mwj*—

(*Continued on page 118*)



THE QUALITY OF YOUR JVM TRIODE CAVITY comes from having made the same type before

Because JVM has already engineered and produced 350 *different types* of triode cavities, chances are good that the triode cavity you need has been produced before. You benefit from JVM's experience and get a triode cavity that has been proven in actual daily operation. And because your prototype is assembled from proven production components, the quality is without equal. Thus, with JVM Triode Cavities you enjoy these three distinct benefits: a 30 day delivery schedule, lower prototype costs and readily available spare parts. And you enjoy the feeling of confidence that comes from buying a triode cavity that has been created, built and proven at least once before. There are definite advantages in discussing your needs with JVM first. Write today for the new technical brochure on JVM TRIODE CAVITIES.

JVM DIVISION OF — **Fidelitone Microwave Inc.**
Chicago 26, Illinois

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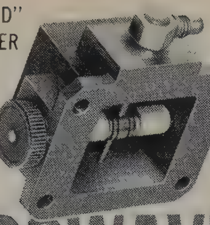


"CROSSED FIELD"
BALANCED MIXER

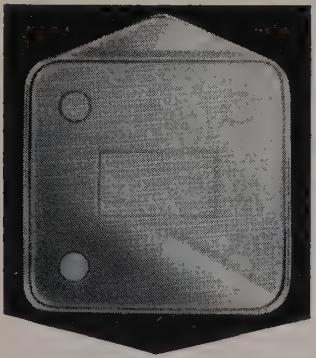
IN MICROWAVE COMPONENTS BUY PERFORMANCE FIRST

In 20 years in this specialized field, Premier has developed unique skills, facilities and design engineering abilities. Whether a standard waveguide unit or an intricate new design, bring your problem to Premier.

PMC

PREMIER MICROWAVE CORPORATION
33 New Broad St., Port Chester, N. Y.
Circle Reader Service Card 78

WAVEGUIDE
PROTECTIVE COVERS



UNBREAKABLE
NON-MARRING

- MANY COLORS WITH CONTRASTING TRADE MARKS AVAILABLE AT LOW COST

Omega
ELECTRONIC CORPORATION
ROWLEY, MASSACHUSETTS

- REQUEST BULLETIN NO. 4 FOR PRICES AND SPECIFICATIONS

New Products

(*Continued from page 116*)

BROADBAND COMMUNICATIONS ANTENNA DEVELOPED

Tamar Electronics, Inc., Gardena, Cal., has announced a new broadband communications antenna, model TC-200, with application to high performance aircraft including commercial and executive jets with speeds to .9 Mach.

The new model TC-200 antenna covers the frequency range 117 Mc to 152 Mc with better than 2:1 VSWR with omnidirectional pattern and power handling capability to 125 watts.

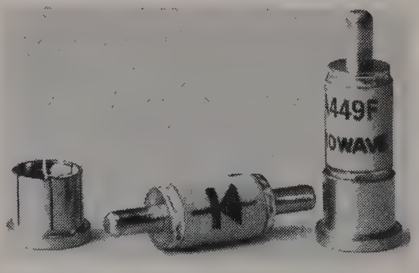
The antenna has been specially designed incorporating a grounded base to eliminate potentials between the antenna and the fuselage, thus reducing lightning dangers and stray signal interference. The low weight factor of only 1.9 pounds coupled with small frontal area and a sweepback angle of 30° reduces drag factor and icing problems to a minimum. The streamlined configuration is also compatible with new aircraft sweptback design.

The design is certified to TSO and qualified to MIL-E-5272.

Circle Reader Service Card 126

—*mwj*—

SILICON RF MIXER DIODES AVAILABLE FROM MICROWAVE ASSOCIATES



Eighty new high reliability silicon RF mixer diodes for extremely low noise mixer performance through 10,000 Mc are available in two cartridge case types from Microwave Associates, Inc., Burlington, Mass.

The fixed base cartridge series (MA-449B through MA-449F) directly replaces EIA types 1N21B through 1N21F. Reversed polarity diodes, MA-449BR through MA-449FR are also available.

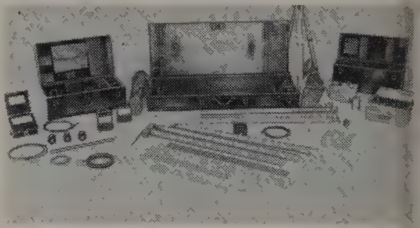
The reversible polarity equivalent types in double-ended cartridge with detachable base adapter (MA-459B through MA-459F) directly replace EIA types 1N416B through 1N416F. The calculated overall noise figure for the MA-449F and MA-459F is 6.0 db (maximum) for 30 Mc IF noise of 1.5 db.

The new types are designed for 150°C operation and are hermetically sealed, using an exclusive metal-to-ceramic solder-seal and solder-end seal construction for highest reliability. They pass applicable military environmental specifications MIL-S-19500. The diodes are particularly well suited for such difficult environmental requirements as airborne and shipboard applications or communications circuits where long term diode reliability is essential.

Circle Reader Service Card 127

—*mwj*—

ANTENNA COVERS 10 KC TO 300 MC RANGE



Newly available from Empire Devices Inc., Amsterdam, N. Y., is Standard Antenna Set, Model SA-301, which permits laboratory standardization of field strength from 10 kc to 300 Mc. The set fills a long-standing need for antennas for accurate calibration of field intensity meters.

The ability of these units to generate an accurately-known field from 10 kc to 30 Mc and to measure accurately an unknown field from 30 Mc to 300 Mc suggests a wide variety of applications. The set, when used with an RF signal source, is complete with all items needed to perform calibration. Components furnished include all necessary loop and dipole antennas, baluns, tripods, precision meters, cables and other accessory items.

All components correspond to a set developed by Empire Devices and certified by the National Bureau of Standards; a copy of the certification report is available from Empire upon request.

Circle Reader Service Card 128

—*mwj*—

(*Continued on page 120*)

Circle Reader Service Card 79

New! SPERRY *Microline*®

SPERRY Microline

MULTIHOLE

Couplers

- HIGH DIRECTIVITY
- MINIMUM COUPLING VARIATION
- CONVENIENT SECONDARY H-PLANE ARM

● Microline Multiholes are precision directional couplers characterized by flatness of coupling and high directivity over broad frequency ranges. These characteristics especially adapt them for broadband matching, reflection measurements and isolation of signal sources. Microline Multiholes may also be utilized as fixed attenuators.

Available in 3, 10 and 20 db coupling values, the Microline 45( )1 couplers cover the range of 2.6 to 40. Gc in eight waveguide sizes. The secondary arm of each coupler is an H-plane bend terminated in a standard flange.

SPECIFICATIONS

*Model	Frequency Gc	W/G Type & Flange	**Mean Coupling Accuracy (db)	Min Directivity (db)	***Input VSWR Max.	Price
45S1	2.6 — 3.95	WR-284 UG-53/U	±0.4	40	1.05	$375.00
45C1	3.95— 5.85	WR-187 UG-149A/U	±0.4	40	1.05	250.00
45G1	5.85— 8.2	WR-137 UG-344/U	±0.4	40	1.05	140.00
45H1	7.05—10.0	WR-112 UG-51/U	±0.4	40	1.05	120.00
45X1	8.2 —12.4	WR-90 UG-39/U	±0.4	40	1.05	100.00
45U1	12.4 —18.0	WR-62 UG-419/U	±0.4	40	1.05	115.00
45K1	18.0 —26.5	WR-42 UG-425/U	±0.7	40	1.05	175.00
45V1	26.5 —40.0	WR-28 UG-381/U	±0.7	40	1.05	200.00

* When ordering, specify coupling by suffix number, eg 10 db X band unit is Model 45X1-10

** The mean coupling is the average of the maximum and minimum coupling values over the frequency range. The variation in coupling over the frequency range is within ±0.5 db of the mean coupling.

*** Values given are for the 10 db and 20 db couplers. Input VSWR of the 3 db couplers is 1.10 max.

SPERRY

SPERRY MICROWAVE ELECTRONICS COMPANY, *CLEARWATER, FLORIDA • DIVISION OF SPERRY RAND CORPORATION*

Microline Instruments *• Radar Test Sets • Systems Instrumentation • Solid State Devices and Materials • Microwave Components and Antennas*

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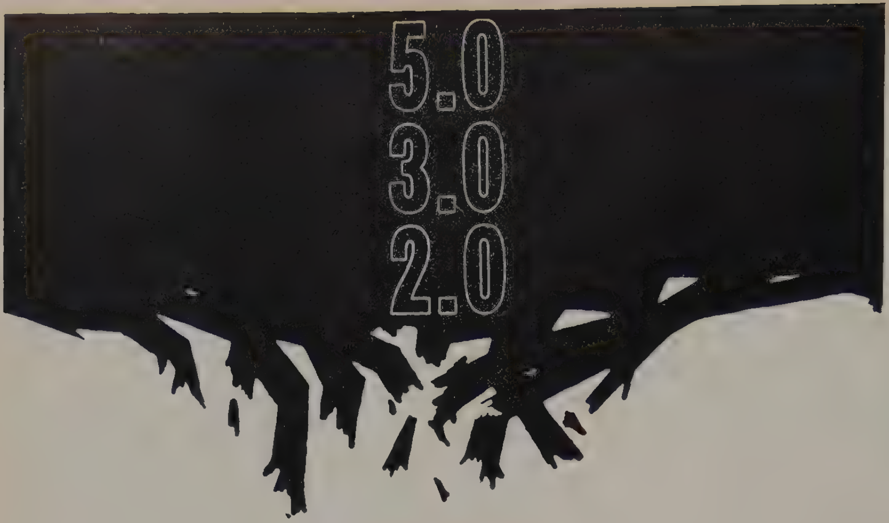
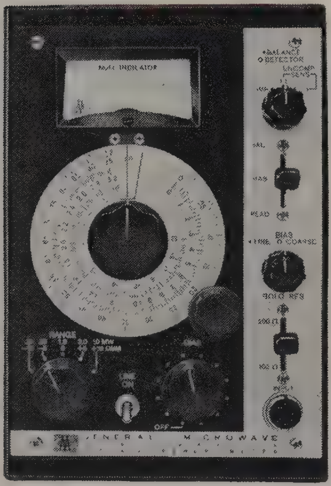


± 0.5 %
ACCURACY



Microwave Power Measurement Breakthrough!

The state-of-the-art of microwave power measurement has taken a giant step forward with the introduction of the General Microwave Model 450 Precision Power Meter. Now it is possible to obtain a direct-reading accuracy of ±0.5% of full scale. The GMC Model 450 exhibits outstanding thermal stability, is easy to operate and can be used to obtain greater precision in the direct measurement of C-W and modulated microwave power. **Specifications:** Accuracy is ±0.5% of full scale. 0.5 microwatt to 10 milliwatts direct-reading power measurement range. Five full-scale ranges from 100 microwatts to 10 milliwatts. 12-inch scale length. Resolution is approximately 0.1% of full scale. Designed for use with GMC Series 402 temperature-compensated waveguide and coaxial thermistor mounts, covering a frequency range from 0.01 to 18.0 Gc. Thermal drift is less than 2 microwatts per degree centigrade. Price, $495.

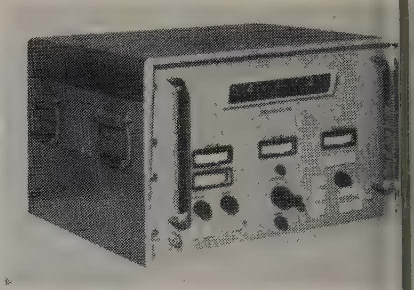
GENERAL MICROWAVE
CORPORATION
47 GAZZA BOULEVARD, FARMINGDALE, N.Y.
MYRTLE 4-3434

Circle Reader Service Card 81

New Products

(*Continued from page 118*)

NEW SIGNAL GENERATOR CHEC OUT COMMAND RECEIVERS



Primarily intended for check out
command receivers in the 400-550
band, the new 412 FM Signal Gener
from Microdot, Inc., South Pasade
Cal., features direct six-place dig
readout of frequency, accurate to wi
in one kc.

Continuous frequency coverage is p
vided by a single tuning control, a
0.0002 per cent accuracy prevails throug
out the frequency range. Frequency s
bility is 0.0005 per cent per hour.

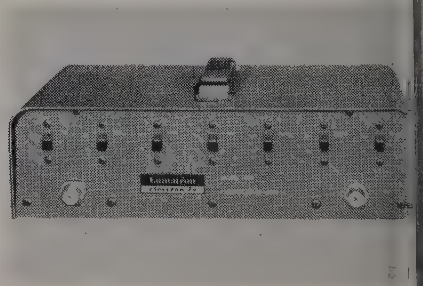
The Model 412 can be frequency mo
lated up to ±300 kc by an external m
ulating signal, varying in frequency fr
300 cps to 100 kc. An internal compressi
circuit maintains a constant peak dev
tion as the modulating signal varies
amplitude, or as one or more tones a
applied.

Applications of the Microdot 412 S
nal Generator include frequency sear
receiver alignment, bandwidth testi
discriminator measurements, sensitiv
measurements, and check out of comma
receivers. Because of its high voltage o
put (0.1 μv to 1 v), the unit can al
be used for impedance and filter atten
tion measurements.

Circle Reader Service Card 129

—*mwj*—

VARIABLE STEP DELAY LINE PRODUCED BY LUMATRON



The Model 1202 variable step dela
line, a new precision device specificall
designed to give discrete, calibrated step
of delay in the nanosecond range, has bee
announced by Lumatron Electronics, Inc
New Hyde Park, N. Y. The instrumen
has a bandpass of approximately 500 M

(*Continued on page 122*)

MICROWAVE PROBLEM?
GEL MAY HAVE ALREADY SOLVED IT

General Electronic Laboratories has encountered and solved a variety of microwave design problems covering receivers, transmitters, antennas and associated servo control systems.

Research and development at the forefront of the state of the art is continuing at company laboratories in Cambridge, Mass., and Silver Spring, Maryland.

Extensively equipped facilities have been developed for testing, model shop work, and manufacturing. Many special manufacturing services are also available like electroforming for the production of cavities, feeds, horns and intricate microwave structures; and fiberglassing for radomes and reflectors.

GEL HAS DESIGNED AND PRODUCED:

ANTENNAS — 20 mc to 47,000 mc
Electronically steerable
Broad-band coaxial horns, bi-circularly polarized
Broad-band dipoles, bi-circularly polarized
Horns and dipoles, linearly polarized
Luneberg lens
Cassegrain
Broad-band slotted arrays
Rhombic
Tetragon

RECEIVERS — 20 mc to 50,000 mc
Telemetry
Communication
Intercept ECM

TRANSMITTERS
FM, AM, Pulse Modulated

SYSTEM ACCESSORIES
Radomes
Rotary joints
Waveguide transitions

SYSTEM ACCESSORIES (Cont.)
Polarizers
Transmission lines
Broad-band waveguide windows
Parametric frequency multipliers
Crystal detectors
Filters
Display devices
High power VSWR indicators
TWT and BWO equipment
True RMS voltmeter-electronic
Power meters
High power servo amplifiers

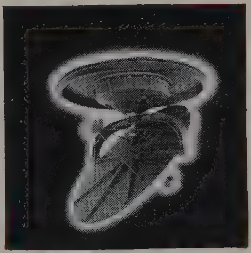
For assistance with your microwave problems, write to:

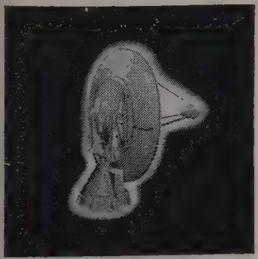
GENERAL ELECTRONIC
LABORATORIES, INC.
18 Ames Street, Cambridge 42, Mass.

1-4 Kmc Coaxial Feed

Dual-Path Rotary Joint
L-S or C-X Band

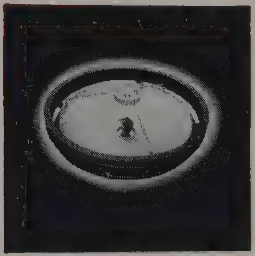
GEL


Servo-Controlled
Passive Reflector

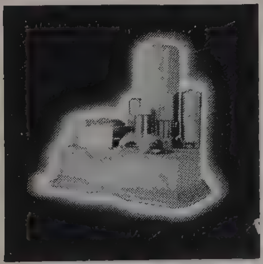

1-11 Kmc High-Gain
Antenna Assembly

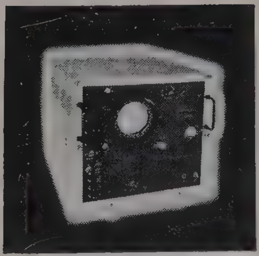
4-12 Kmc Coaxial Feed

Telemetering
Antenna Assembly


10-50 Kmc Cassegrain
Antenna Assembly

Parametric Frequency
Doubler — 15 to 20 Kmc Output


Servo Drive System Assembly


DF Control Indicator

Electroformed
Tuning Cavities

Circle Reader Service Card 82

MICROWAVE ABSORBERS

1.02 VSWR MAX.

GUARANTEED

ON CATALOG ITEMS

Fifteen Different formulations
EMA from 7033 to 7300
db/in X-Band 33 to 300.
--REPRODUCIBLE BATCHES
-- GUARANTEED QUALITY
-------- FAST DELIVERY

Spears, Cones, Wedges,
Steploads, Bars, Rods, Damping
Rings, Coaxial Lines.
High Power Material Next Ad.
Write for Technical Bulletin.

ELECTRONAUTICS
CORPORATION
MAYNARD, MASS., TW 7-8844
Circle Reader Service Card 83

ANTENNA PEDESTAL
SCR 584 — MP 61B
Full azimuth and elevation sweeps. 360 degrees in azimuth. 210 degrees in elevation. Accurate to 1 mil. or better over system. Complete for full tracking response. Angle acceleration rate: AZ. 9 degrees per second squared EL.4 degrees per second squared. Angle slewing rate: AZ 20 degrees per sec. EL. 10 degrees per sec. Angle tracking rate: 10 degrees per sec. Quantity in stock for immediate shipment.
Complete description in McGraw-Hill Radiation Laboratory Series, Volume 1, page 284 and page 209, and Volume 26, page 233.

AUTOMATIC TRACKING RADAR
SCR 584 is in like new condition, ready to go, and in stock for immediate delivery. Fully Desc. MIT Rad. Lab, Series. Vol. 1, pp. 207-210, 238, 284.

CARCINOTRON
Type CM 706A Freq. 3000 to 4000 mcs. CW output 200 watts mim. Factory New

MIT MODEL 9 PULSER
1 MEGAWATT-HARD TUBE
Output pulse power 25KV at 40 amp. Max duty ratio: .002. Uses 6C21 pulse tube. Pulse duration .25 to 2 microsec. Input 115 volts 60 cycle AC. Includes power supply in separate cabinet and driver. Fully guaranteed as new condition. Full Desc. MIT. Rad. Lab. Series "Pulse Generators."

MIT MODEL 3 PULSER
Output: 144kw (12kv at 12 amp). Duty ratio: .001 max. Pulse duration: .5, 1 and 2 micro sec. Input: 115v 400 to 2000 cps and 24vdc. $325 ea. Full desc. Vol. 5 MIT Rad. Lab. Series pg. 140.

AN/AAS-6 Infrared Detection System, complete. New $5500.

AN/TPS-1D RADAR
500 KW. 1220-1350 MCS. 160 nautical mile search range P.P.I. and A Scopes. MTI. Thyratron Mod. 5J26 Magnetron. Like new. Complete system incl. Spare parts and gas generator field supply.

RADIO RESEARCH INSTRUMENT CO.
550
FIFTH AVE.
NEW YORK
JUDSON
6-4691

(*Continued from page 120*)

and consists of seven steps of 1, 2, 2, 5, 10, 20 and 20 ns of coaxial delay. These steps can be added in any combination to provide total values of delay from one ns to 60 ns — merely by pushing a coaxial slide switch.

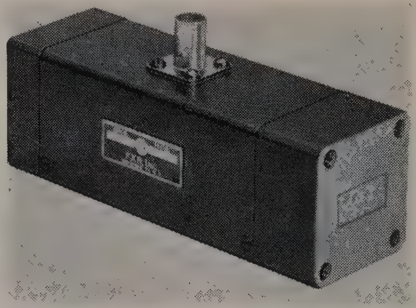
The model 1202 is a convenient, compact laboratory instrument providing a wide range of delay for nanosecond applications. It is particularly useful as a delay calibration tool, and for making accurate, high frequency phase and pulse delay measurements.

Calibrated lengths of coaxial delay line with signal input and output connectors are housed in a convenient modular cabinet — 12 3/4 inches wide x 10 3/4 inches deep x 3 5/8 inches high (rack mounting optional). The steps of delay are added, or removed from the signal path with specially designed, high frequency coaxial switches.

Circle Reader Service Card 130

—*mwj*—

AM MODULATOR COVERS ENTIRE X-BAND



A new ferrite AM modulator designed to cover the entire X-band, 8.2 to 12.4 Gc has recently been introduced by FXR, Woodside, N. Y., a division of Amphenol-Borg Electronics Corp.

This new unit, known as the X-158A is the first absorption amplitude modulator to cover the entire X-band for a multiplicity of applications. A primary use of this unit is to provide a clean AM microwave signal for high accuracy measurements. Previously, any attempt to modulate a microwave source for high accuracy measurements left much to be desired because of error-producing FM, jitter and double moding . . . all due to the inherent characteristics of the microwave source.

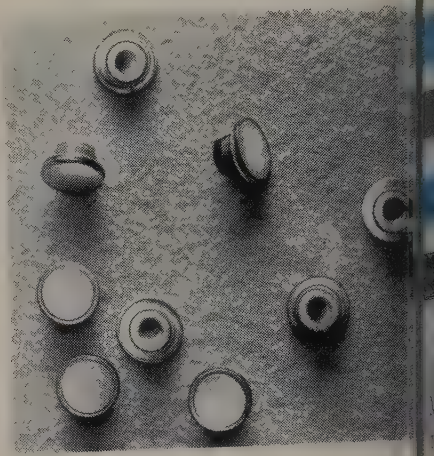
Other applications include microwave transmitter modulation, microwave switching and electrically controlled microwave attenuation. With the X-158A, all of these functions can be controlled either from a local or remote position.

The modulator coil of the X-158A has been designed so that any standard, one watt, commercial audio oscillator will provide substantially 100 per cent modulation at 1000 cps. Features other than the low driving power requirements are: 30 db minimum dynamic attenuation ove the entire band, metallized plastic con struction for high frequency audio re sponse. Low insertion loss of one d maximum is attained without the need c coil current.

Circle Reader Service Card 131

—*mwj*—

GaSb TUNNEL DIODE AVAILABL FROM MICRO STATE



Tunnel diodes made from GaSb, a com pound semiconductor, are now availabl from Micro State Electronics Corp Murray Hill, N. J. Types MS 232-3-4 dem onstrate the excellent low noise and hig frequency properties obtainable fron Gallium Antimonide Tunnel Diodes ove a temperature range of —55°C t +100°C.

The units are especially designed fo use in low noise UHF and microwav amplifiers. They feature cutoff frequencie in the two to four kMc range as well a noise constants 40 per cent less than tha obtainable from germanium units.

At present, the available peak current are one ma and three ma with a 10 pe cent variation allowed. The peak-to-valle ratios of GaSb tunnel diodes are superio to germanium units. Typical peak-to-valle ratios of these commercial types are 16: and 20:1. All types are in the pillbo package which has a low series inductanc of 0.3 mμh and is ideal for use in stri line, coax or wave guide circuitry.

Circle Reader Service Card 132

—*mwj*—

HIGH-VOLTAGE DC POWER SUPPLY FEATURES STABILITY OF ±0.005% PER HOUR

A high-stability, high-voltage dc powe supply featuring stability of ±0.005 pe

(*Continued on page 130*)

Circle Reader Service Card 84

Yours in this NEW hp STANDING WAVE INDICATOR

- **Pinpoint resolution for precise attenuation measurements**
- **Scale expansion with no "blind spots," no resetting**
- **Built-in bolometer protection**
- **AC or battery operation**
- **All-solid-state design**

hp 415C Standing Wave Indicator

Model 415C Standing Wave Indicator is a new high-gain, low-noise solid state amplifier and voltmeter calibrated for square-law detectors to read directly in SWR or db. The amplifier is tunable, 980 to 1,020 cps, for matching source modulator or for optimizing several instruments in one system. Variable bandwidth (15 to 100 cps) permits both high sensitivity testing and swept-frequency work.

For highest resolution on precise attenuation measurements, you can expand to full scale each 2.5 db portion of any 10 db range with no "blind spots," and the reference is maintained automatically! This expansion gives you 24 calibrated ranges, 0-60 db, in 2.5 db steps. The 415C also reads directly in SWR; it is ideal for measuring reflection coefficient and extremely useful as a null indicator for audio-frequency bridges.

Two peak-limited bias currents, readable on the front-panel meter and adjustable ± 10%, prevent accidental bolometer burnout. Other inputs permit operation with crystals and as a null detector.

The 415C has both an ac output for use as a high-gain tuned amplifier and a dc recorder output. High stability with line changes makes the instrument ideal for long-term monitoring. An internal battery pack (optional) makes the 415C completely portable. It is housed in the new hp modular cabinet, which can mount in half of a rack 7" high, combining conveniently in a single rack width with such companion instruments as hp 431 Power Meter.

SPECIFICATIONS

Frequency:	1,000 cps ±2% by front-panel control. Special-order frequencies available between 400 and 1,500 cps.
Sensitivity:	0.1 μv rms at 200 ohms and 30 cps bandwidth.
Noise Level:	5 db below full scale at 0.1 μv rms sensitivity, minimum bandwidth.
Bandwidth:	Variable, front-panel control, 15 to 100 cps.
Range:	70 db. Input attenuator for 60 db in 2.5 db steps, accuracy ±0.1 db/10 db step. Maximum cumulative error, ±0.2 db.
Expand Accuracy:	±0.05 db from normal to 0.1 db expand; ±0.1 db from normal to other expand ranges
Meter Scales:	SWR 1-4; SWR 3-10; expanded SWR 1⅓ db 0-10; expanded db 0-2.5. Bolo current.
Input:	"Bolo"—200 ohms, bias 8.7 or 4.3 ma; "Crystal"—200 ohms for crystal rectifier; "200 Kilohm"—for crystal rectifier as null detector.
Outputs:	DC (1 ma full scale) for recording. AC (0.25 v rms for full scale deflection) for swept-frequency scope presentation.
Size:	7½" high, 6½" wide, 12½" deep. Weight, 5 lbs.
Accessories Available:	Battery pack.
Price:	$325.00.

Data subject to change without notice. Prices f.o.b. factory

HEWLETT-PACKARD COMPANY
1085C Page Mill Road Palo Alto, Calif., U.S.A.
Cable "HEWPACK" DAvenport 6-7000
Field representatives in all principal areas

HEWLETT-PACKARD S. A.
Rue du Vieux Billard No. 1 Geneva, Switzerland
Cable "HEWPACKSA" Tel. No. (022) 26. 43. 36

ANOTHER
ADVANCED
MICROWAVE
TUBE
DEVELOPMENT

RAYTHEON
QKW928
MADE IN U.S.A.
SERIAL NO
139
138
137

COMPACT C-BAND TWT, QKW 928, utilizes PPM focusing for lightweight construction. VSWR is 1.1 over any 50 Mc channel. Tube is also available with coaxial fittings for full octave (4-8 kMc) coverage.

Raytheon introduces low-cost 12-watt TWT for long-life microwave relay operation

Rugged all metal-ceramic tube for 5,925 to 7,125 Mc range designed for power amplifier service in unattended stations.

The QKW 928 offers a combination of advantages never before available in a traveling wave tube for communications applications.

This 12-watt tube's periodic permanent magnet focusing permits a new, simpler, more compact construction that assures long life and permits a lower cost. The new design reduces external magnetic fields so that two tubes can be mounted in close proximity to each other.

Write today for detailed technical data or application service to Microwave and Power Tube Division, Raytheon Company, Waltham 54, Massachusetts. In Canada: Waterloo, Ontario.

QKW 928 TYPICAL OPERATING CHARACTERISTICS

Frequency Range	5,925-7,125 Mc
Power Output (saturated)	12 Watts minimum
Small Signal Gain	36 db
Helix Voltage	2,600 Vdc
Collector Voltage	2,600 Vdc*
Anode Voltage	2,650 Vdc
Filament Voltage	6.3 Volts

*Can be depressed to 1,400 volts for improved efficiency.

RAYTHEON

RAYTHEON COMPANY

MICROWAVE AND POWER TUBE DIVISION

Circle Reader Service Card 86

own are (above) TRG Syosset, Long Island plants, and (below) TRG's East Boston facility, where together with the Somerville oratory, the antenna and microwave work is carried out.

OMPANY PROFILE

TRG, Incorporated

Syosset, Long Island

Technical Research Group was organized in 1953 by Dr. ernard Lippmann (physics), Dr. Lawrence Goldmuntz lectrical engineering), Dr. Alan F. Kay (mathematics) nd Dr. Jack Kotik (mathematics). In three years the aff increased to about 30 professional people working imarily on study and consulting contracts in the fields radar systems, doppler navigation, nuclear magnetic sonance, electromagnetic theory, antennas and radomes, asmas, and hydrodynamics.

In its early years TRG entered new fields usually as a nsequence of new senior people joining the staff. The end was fostered by a company policy to welcome new oups seeking a congenial atmosphere in which to work nd association with competent people in related areas. this way the company entered the fields of nuclear re- tors and shielding, atomic frequency standards, spectro- opy, and operation research. By 1958 the company nsisted of a large collection of small working groups any of which showed considerable promise.

In 1955 the company moved from its original offices 45th St. in New York City to a downtown building here it started its first laboratories and shop. The early bs were in antennas and microwaves, spectroscopy, ock tubes, and electronics.

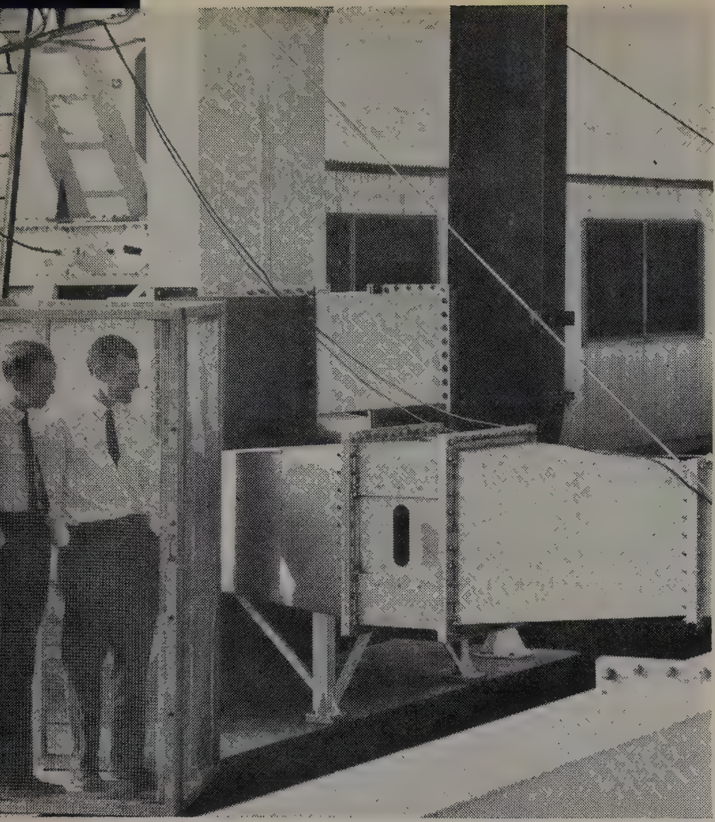
In this early period TRG had many of the aspects of the "ideal" scientific research organization. About half of the professional people had PhD's. Emphasis was on individual research and personal fulfillment. Organization was kept to a minimum. An informal, creative atmosphere prevailed.

Almost from the beginning, however, the chill breeze of competition was felt, and over the years with the increased pressure of universities, non-profit service-sponsored corporations, and the large company laboratories it became more obvious that TRG could not continue to flourish in this manner. A gradual transformation to a product oriented industrial organization started and, in most of the TRG areas of interest, is now fairly complete.

The transformation has not been a painless process. From the beginning management favored activities which seemed to offer the ultimate promise of significant growth and production. However, it was six years before the first successful products were launched. Significant factors in this long process were

a. lack of production experience in most of the senior people

b. strong devotion to pursuing government sponsor-



Mats Viggh and Alan Kay observe high power tests of section of UHF slot array at Lincoln Laboratory.

ship coupled with conservative company sponsorship attitudes

c. concentration of attention on "ultimate" or "revolutionary" products having long lead development periods before being ready for market.

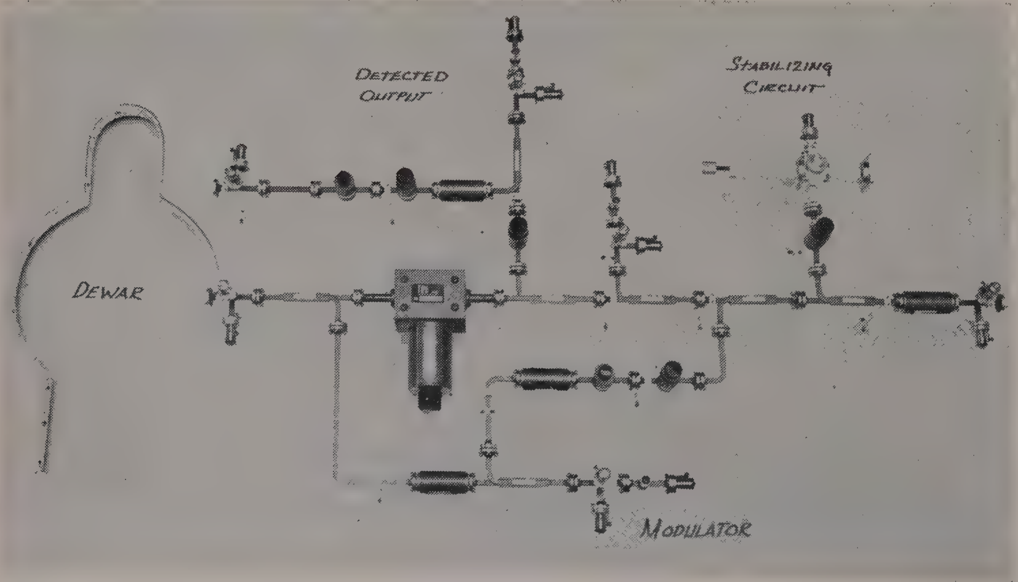
TRG attempted and in some cases engaged in working agreements with larger companies involving royalty payments, joint ventures, etc., to help develop these products and product ideas. The ventures were not particularly successful, but the experiences were educational and the lessons well-learned.

The organization is proud of the diversity of significant achievements in this period, including the:

- First practical doppler adapter to provide ground position information from research, navigatio and fire control radars.
- First design of a ship's hull that minimizes wav resistance.
- First cylindrically focused sealed atomic bear tube.
- Design of a streamlined boresight radome achieving lowest boresight error without empirical correction.
- First proposal for the generation of coheren light at high intensities.
- First program to develop an optically pump MASER.
- Most efficient Monte Carlo transmission codes current use in nuclear shielding calculations.

In 1957 Dr. Kay, along with Dr. Alan Simmons veteran of NRL, opened a TRG laboratory in Somerville Massachusetts, where most of the antenna and microwav work of the company was transferred. The followin year the New York City facility was relocated to its present quarters in Syosset, Long Island. The numerou small groups were consolidated and strengthened an the present department organization was instituted. Th departments in Syosset are now electronics, systems, nuclear, hydrodynamics and radomes, and optical and microwave spectroscopy.

The electronics department at Syosset fabricates prototype equipment for the systems and spectroscopy departments. It also has developed simulators of various type and doppler airborne navigational equipment. The systems department has responsibility for the developmen of the GUSTO satellite navigation program and certai advanced sonar and aircraft collision avoidance and station keeping systems. The mathematical analysis o reactor shielding and reactor performance as well a some projects in radiation chemistry are the responsibilit of the nuclear department. The optical and microwav spectroscopy department has been heavily involved i atomic frequency standards of the cesium beam and ga cell variety. It has been engaged for some time in substantial LASER program and mm-wave low-noise amplifier development. Problems associated with minimum



E band (60-90 kMc) microwave measurement circuit built from TRG components. Circuit provides pump and signa power at amplifier inpu as well as heterodyning signal for detecting amplifier output. A singl klystron, phase-locked t harmonic of stable reference frequency through sixth harmonic mixer generates all signals Short term stability parts in 10^8.

taff meeting, left to right, Bruno J. Pawlowski, Alan Simmons, Gerald Brown, Alan Kay, Mats Viggh, Orville Giddings, Robert acobson.

ave resistance hulls, ground effect vehicles, ship stability ave concerned the hydrodynamics department.

Late last year the company launched a new venture, eneral Astrometals, Inc., whose primary role is the sale nd fabrication of beryllium shapes manufactured by hot ressing and extrusion. Astrometals now occupies a ewly equipped plant in Yonkers and with the help of n exclusive U. S. license from Pechinay for raw material expected to become one of the three major suppliers f beryllium in the next year.

ntenna Research

TRG has had continued government support in antena research. In addition to Kay and Simmons, work as been carried out by Dave Cope, John Nihen, R. Openheim, Sylven Cutler, Jerome Lurye, and others.

Topics on which studies have centered include mutual oupling of slots in waveguide arrays, multiple feeds for ide angle and high performance reflectors, theory of urface wave antennas, yagi array design, near field probems, missile seeker antenna design, low silhouette endre arrays, side lobe reduction techniques, electromehanical scanning, line source feeds for spherical reflecors, and cassegrain design.

These research projects have been aimed toward a etter understanding of antenna phenomena. Typically ey have combined theoretical and experimental investiations supplemented by digital computer calculations. Use is made of TRG's own computer, the Alwac 3E, but rograms also have been written for the IBM 7090 and ther machines.

Similar work has been performed for other organizaions such as RCA, Raytheon, LFE, and MIT, but these obs have been oriented toward consulting or product evelopment.

Millimeter Wave Components

During 1956-58, under Dr. Simmon's supervision and ith the assistance of Senior Engineer Robert Jacobson, ormerly of Airtron, TRG developed all of the microwave components which could not be obtained elsewhere for several millimeter wave radar systems. These included ferrite isolators, duplexers, switches, circular electric mode components, and antennas. When this work was completed, a market survey showed that there was a definite need for a commercial supplier of similar components. It was determined that if TRG would supply a complete millimeter line, including the more standard test bench equipment as well as the antennas and ferrite items which were not then being offered by other suppliers, if quality and engineering were stressed, if performance and delivery estimates were conservatively made and adhered to, if prices were reasonable and customer services properly attended to, and finally if a vigorous R and D program were instituted and operated to keep the line expanding to meet the growing needs of the market then TRG could overtake the few existing manufacturers and become the leading millimeter components supplier in the United States. This was the course decided upon, and a healthy capital commitment was made to it.

Gerald Brown, formerly chief engineer at both Diamond and Gabriel, was brought in to head the new line. The first catalogue appeared early in 1960. A continuing company sponsored development program was instituted, which by the end of 1960 resulted in adding to the original novel items, such standard items as loads, tuners, pads, couplers, detector mounts, etc. in the three common millimeter bands (A: 26.5 - 40 kMc, V: 50 - 70 kMc, and E: 60 - 90 kMc). In addition TRG came out early in 1961 with the Ferrimat*, an isolator tunable over the whole waveguide band, a precision attenuator, miniature bolometers, harmonic mixers, and a number of F band items (90 - 140 kMc). At the same time in the millimeter antenna line, TRG offered gain standard horns, lenses, and dishes in a range of sizes from three inches to 36 inches, including mounts, feeds, (linear, circular or switchable polarization), complete with pattern tests.

Further items which have been more recently perfected

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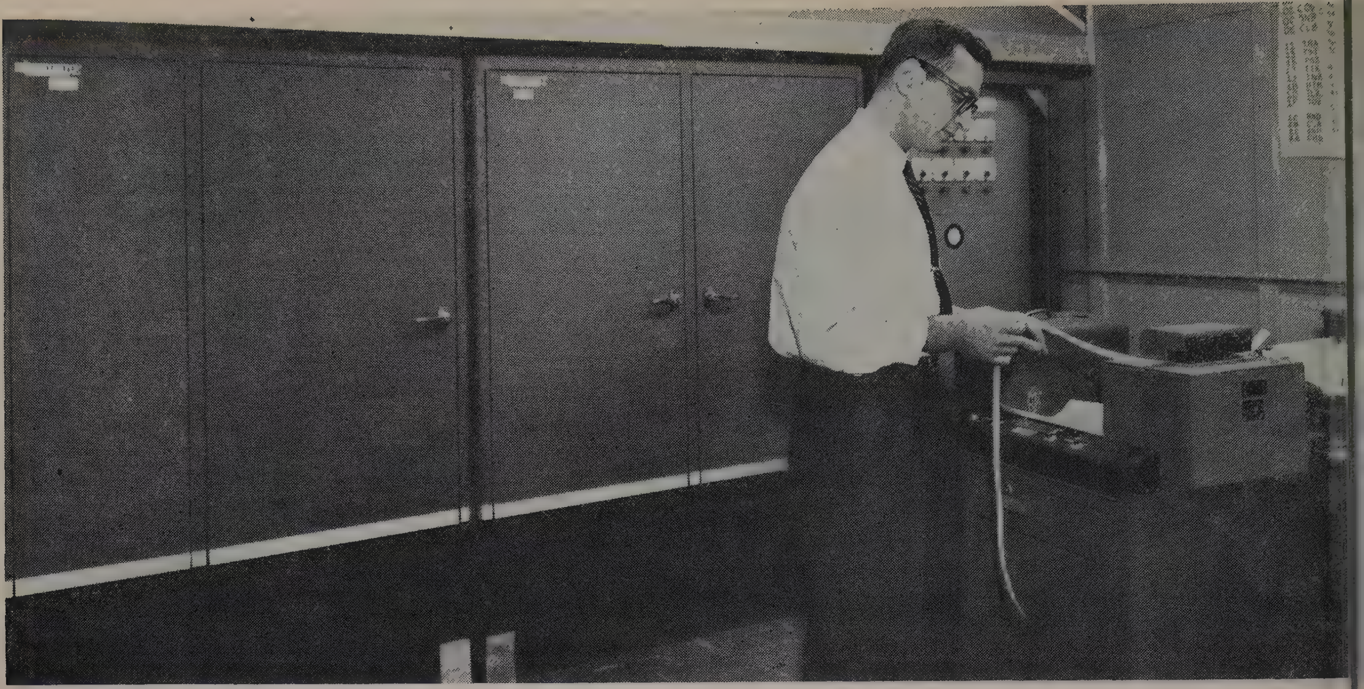
* *Pat. pending.*



TRG's computer, the Alwac III E.

include slotted lines, calorimeters, hybrids, and noise tubes. Improvement of the line and increasing the model variety continues.

Recently work has begun on a complete line of high performance components centered in the 3 mm "atmospheric window" band, emphasizing especially novel low-loss components in circular electric mode.

Also in process is the development of low noise millimeter wave amplifiers in cooperation with the physics group in Syosset.

Engineers in the TRG development programs besides Brown, Simmons, and Jacobson are Orville Giddings, Richard Davis, Clayton Kenney and Mats Viggh.

Great care has been taken in developing and publishing adequate specifications to which each item must adhere. It is expected that by the end of 1961 the millimeter components sales volume, excluding sources will exceed that of any other manufacturer.

Large Antennas

In 1960 TRG was selected to design and build the UHF, dual polarization, high power line source feed and associated components for the radio observatory at Arecibo, Puerto Rico. An X-band scale model was successfully tested with a scaled section of a sphere in the design phase of the project. The final feed will weigh five tons and be a precision aluminum fabrication, 105 feet long. The feed is both a traveling wave array and a high performance structural member. The satisfactory solution of the generally conflicting electrical and structural design requirements has helped make TRG a leading contender in large antenna sub-systems, where these factors are important. Such items include multi-element, multi-band feeds, and multi-channel rotary joints. Leading TRG engineers in the mechanical-structural field are Bruno J. Pawlowski, formerly chief engineer at Gabriel with 20 years experience in the antenna field, and Irving Melnick, who brings aircraft structural experience gained at Republic and Aerojet.

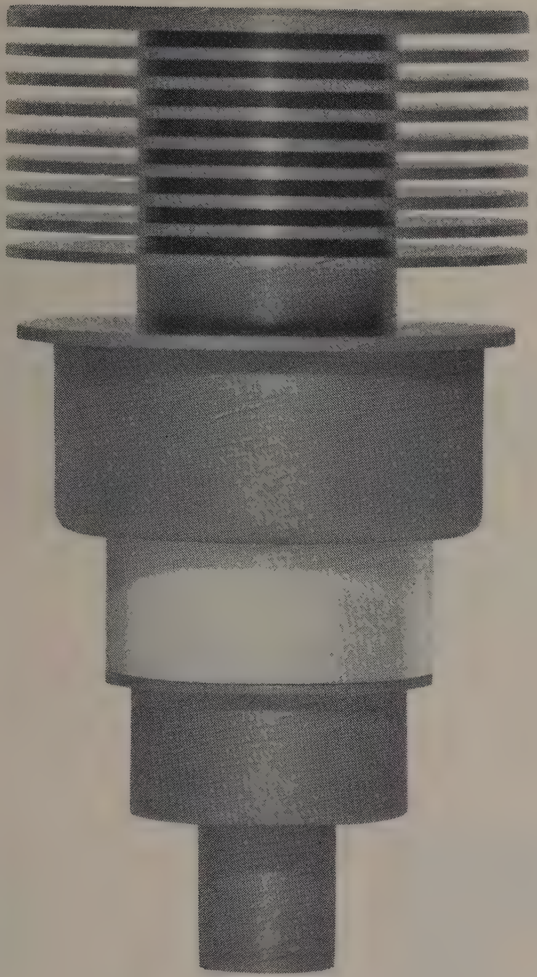
In view of its growing responsibilities in this electro-structural area, TRG acquired a 25,000 square foot facility in East Boston near Logan airport, especially for large antenna work. The 60 foot x 160 foot antenna erection and test area of this building is a heated, clear space with 34 foot stud height. The controlled heating feature is considered very important for precision fabrication and test work. The area is served by a ten ton bridge crane. Additional features of the building include ample parking and outdoor assembly area, laboratory and office space, pattern range provision, and ample truck and dock-side ship loading facilities.

Company Organization and Future

TRG stock is privately held. About 70 per cent is owned by the engineers and scientists who are full time employees, 15 per cent is owned by the Aerojet General Corporation, and the remainder by investment groups. An adequate block is reserved for stock options.

The gross volume of the company has increased steadily at the rate of 25-30 per cent a year for the last five years. 1960 volume is anticipated to be $2.8 million. The company has made money in every year of operation. Net profit before taxes has hovered around seven per cent. It is expected that growth will be at a greater rate in 1962 and subsequent years because of the recent introduction of production items and commercial products. Besides the microwave and antenna lines already described, the company offers a line of laser range finders and research instruments, doppler navigation equipment, and packaged electronic assemblies. Finally, the growth rate in the beryllium field is expected to be very large. A total volume of 20 million by 1965 seems a reasonable goal.

The antenna and microwave activities of the company are centered in the facilities at Somerville (mm components) and East Boston (large antennas) which together now operate as an independent division and account for about 20 per cent of the total volume.



UHF

Frequency Stable

CW or Plate-Pulsed

ML-7855

pecial anode design of ML-7855 permits frequency stable operation within 10-15 seconds fter application of high voltage. (Frequency change during this initial period is within 1 mc).

L-7855 provides frequency stable operation with unregulated supply, as change of plate issipation has no effect on change of frequency.

W operation to 2500 Mc, with 1000 V Ebb, 100 ma Ia.

late-pulsed to 3000 Mc, with 3500 v eb, 3.0 a ib, with a tp of 3 usec at 0.0025 Du.

Send for Machlett UHF Planar Tube Brochure

MACHLETT

Subsidiary of Raytheon Company

The Machlett Laboratories, Inc.
Springdale, Connecticut

Circle Reader Service Card 87

New Products

(*Continued from page 122*)

cent per hour, ±0.02 per cent for an eight-hour period, is now available from NJE Corporation, Kenilworth, N. J.

Designated the HSV-5-20, it has an output of 50 to 5,000 V and 0-20 ma. Input power is 105-125 V at a frequency of 55-65 cycles. Maximum ripple (mv) is five P-P. Static regulation is 0.01 per cent maximum load for no-load to full-load change at constant voltage, and 0.01 per cent maximum line for line voltage change of 105-125 V ac at any constant load from zero to full load of rating. Dimensions are 8 3/4 inches x 19 inches x 18 1/4 inches. Approximate shipping weight is 80 pounds.

The HSV-5-20 is completely free of harmful "overshoot" when it is turned on and off. When the filament switch is turned on, a time delay (maximum 60 seconds and minimum of 20 seconds) will be required before the high-voltage switch will allow the high voltage to be turned on.

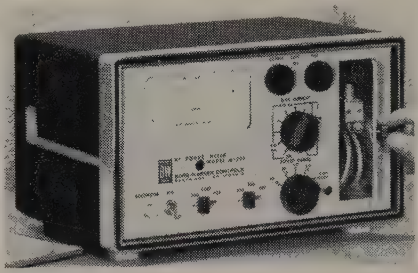
Price is $690. Engineering assistance and/or a catalog are available upon request.

Circle Reader Service Card 133

—*mwj*—

BORG-WARNER CONTROLS ANNOUNCES EXPANDED LINE OF TEST EQUIPMENT

Development of a newly designed line of precision meters and signal generators to supplement its established line of RF equipment has been announced by Fred T. Miller, Vice President and General Manager of Borg-Warner Controls, Santa Ana, Cal.



The new line of test instruments includes vacuum tube voltmeters, volt-ohm meters, VSWR indicators, RF power meters, and signal generators spanning the frequency spectrum from HF to SHF.

All instruments in the line feature clean functional styling, with no unsightly bulges or protrusions. The modern, low silhouette horizontal packaging provides recessed, fold-away handles at both ends of the metal case. This makes the instruments easy to carry with one or two hands and easy to store or stack.

A simplified front panel design, with well-spaced, clearly marked controls and large, recessed meters, makes the new instruments exceptionally easy to operate and read. The meter line, for example, features an indicating meter with enlarged 100-degree scale for quick, clear read-out. This line also provides a special swing-away stand attached to the front feet which permits tilting the meter to a 12-degree angle for added convenience in use.

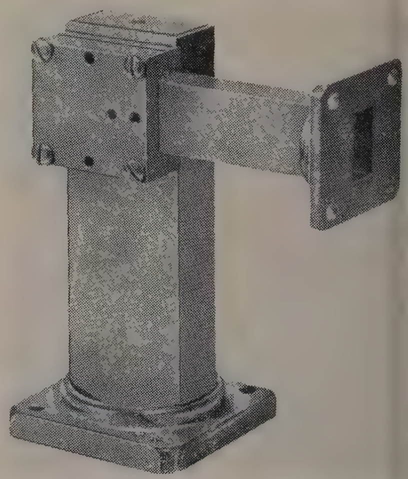
Circle Reader Service Card 134

—*mwj*—

PARAMETRIC FREQUENCY MULTIPLIER USES VARACTOR-DIODES

A new line of parametric frequency multipliers using varactors as the active elements, providing output frequencies ranging from one megacycle to as high as 40 gc, and multiplications up to twenty has been announced by General Electronic Laboratories, Inc., Cambridge, Mass.

The devices have produced output power levels from microwatts up to tens of watts with bandwidths of less than .1 per cent to greater than waveguide pass bands. Efficiencies run up to 85 per cent at lower frequencies.



Individual units with multiplications of from two to 20 times are available. The lower order multipliers, doublers, triplers, quadruplers, may be interconnected for convenient laboratory frequency sources.

As single devices and in tandem operation the GEL parametric multipliers may be applied with high frequency and microwave local oscillators (crystal controlled or tunable), signal generators, completely solid state exciters and transmitters, phase-locking sources for high power transmitters and in similar applications.

Circle Reader Service Card 135

—*mwj*—

PRECISION WAVEGUIDE BENDING

TO YOUR SPECIFICATIONS

Bends, Twists, Offsets, Coils,
Transitions, Fabrications and
complete assemblies to your prints.

Specialty
AUTOMATIC MACHINE
CORPORATION

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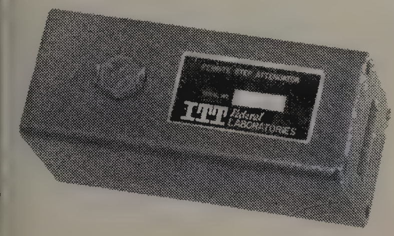
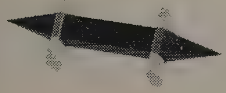
Circle Reader Service Card 67

ITT DESIGNS X-BAND FERRITE STEP ATTENUATOR

ITT Federal Laboratories, Fort Wayne, nd., has designed an X-band ferrite step ttenuator providing up to 50 db of at-enuation.

The device features low VSWR and ow insertion loss. Attenuation is ad-usted by passing a direct current through magnetizing coil around a waveguide ontaining a length of ferrite material. apered at both ends, the ferrite is of ectangular cross section coincident with he waveguide axis. It is in two pieces andwiching strips of resistive card paral-el to the electric field.





Price depends on quantity of order; de-ivery is in six weeks or less.

Circle Reader Service Card 136

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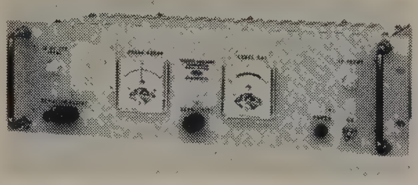
TRANSFER OSCILLATOR SYNCHRONIZER MEASURES FREQUENCY TO 12.4 GC



A new Transfer Oscillator Synchronizer which permits frequency measurement up to 12.4 gc with accuracy up to three parts in 10^8 or better has been announced by Dymec, a Division of Hewlett-Packard Co., Palo Alto, Cal.

The new device is used with a transfer oscillator and an electronic counter to provide simpler, more accurate and more useful frequency measurements from 200 Mc to 12.4 gc.

The Model DY-5796 Transfer Oscillator Synchronizer provides positive locking of the transfer oscillator to the signal frequency. Thus, the hand tuning normally associated with transfer oscillator techniques is eliminated, and measurement accuracy becomes equal to that of the counter time base. Accuracy of 3 parts in 10^8 is obtained with the internal time base of counters such as the Hewlett-Packard Models 524C or 524D; even greater accuracy can be obtained using an external time base.

The Transfer Oscillator Synchronizer also permits long term measurements of low drift rates at microwave frequencies, and simplifies measurement of FM deviations up to ±0.2 per cent.

Model DY-5796 is priced at $685.00 and is available for immediate delivery.

Circle Reader Service Card 137

—*mwj*—

CUSTOM-DESIGNED SHIELDED FERRITE ISOLATORS FOR AIRBORNE SYSTEMS ANNOUNCED

Sylvania Electric Products Inc., Mountain View, Cal., has announced the availability of magnetically shielded ferrite isolators for operation from 1.0 Gc to 11.0 Gc.

Designed for use in compact systems where component space is severely limited, the new isolators function in close contact with other magnetic materials with no degradation of performance or adverse effect on adjacent circuitry. They offer 10 to 1 isolation-to-insertion-loss ratios with maximum VSWR's of 1.3 to 1.

Typical bandwidths are 1.36-2.56 Gc, 4.2-6.0 Gc, and 4.8-7.0 Gc. All performance characteristics are maintained from —30°C to +60°C. Moreover, the units can be fitted with any standard coaxial connector.

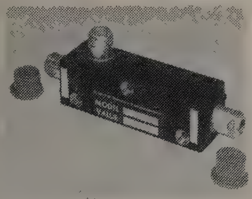
Circle Reader Service Card 138

—*mwj*—

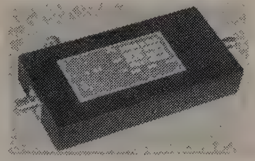
(*Continued on page 132*)

COAXIAL DIRECTIONAL COUPLERS

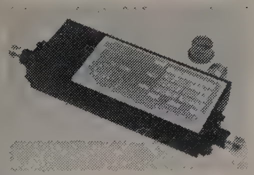
Standard — Or Developed To Your Requirement



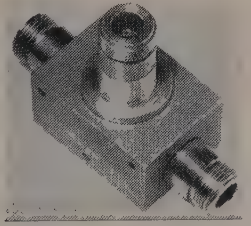
Special Compact 20 db, 400 Mc



Standard RDC-Series
2:1 Bands, 250-4000 Mc
10, 20, 30 db Coupling



Special 5-6 KMC, 10 db Coupler — with TNC Connectors



Special L-Band, Compact 10, 20, 30 db Couplers

Perpetual, in-the-house Development Programs make R-D-C the Microwave Industry's *most versatile* supplier of SPECIAL and STANDARD Coaxial Components:

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New Products

(*Continued from page 131*)

TELEMETRY TRANSMITTER DEVELOPED BY DUKANE

A small, all solid state, crystal controlled telemetry transmitter (FM-CW) developed by the DuKane Corp., St. Charles, Ill., manufacturer of electronic and electromechanical equipment, is now being used successfully in telemetry and tracking operations. The transmitter, the DuKane N15A125 is only five inches x five inches x 1 7/8 inches and weighs less than 20 ounces, including potting.

All conducting surfaces are of silver-plated aluminum and the units are completely transistorized, using only commercially available transistors and diodes. The transmitter is designed to withstand extreme conditions of shock, vibration and temperature.

General specifications of the unit are: size: five inches x five inches x 1 7/8 inches; weight: 20 oz.; supply: 20-24 volts; frequency: 135 Mc band; output: 500mw-20v, 1000mw-24v; efficiency: 30 per cent; operation temperature: 0°C to 50°C; temperature stability: one part in 10-6 for 5/5°C increment.

Circle Reader Service Card 139

—mwj—

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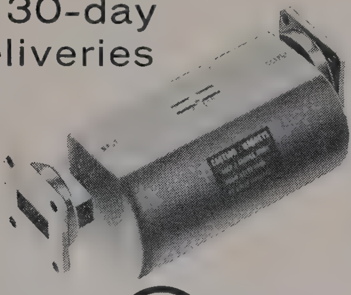
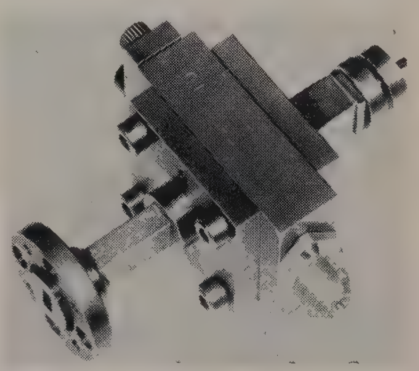


V-BAND CRYSTAL HOLDER ANNOUNCED BY TRG

Technical Research Group, Antenna & Microwave Department, Somerville, Mass. announces a new tunable detector mount designed for use with the Philco 70 kMc mixer diode.

The holder features a tuning adjustment that allows any crystal to be matched to the line. High precision tolerances at input end of waveguide leading to the crystal allow holders to be used as balanced pairs in mixer circuits. An O-ring seal allows use of the holder in pressurized systems. Output connector can be specified as miniature BNC, Microdot or Sealectro.



The holder mates with RG-98/U waveguide by means of UG-385/U connectors. Crystals can be matched to less than 2.0 VSWR, and selected crystals less than 1.5 VSWR.

Circle Reader Service Card 140

—mwj—

HIGH-SPEED, ALL-SOLID-STATE WAVEGUIDE SWITCHES INTRODUCED

Three new high-speed, all-solid-state waveguide switches for use in microwave applications have been introduced by Microwave Associates, Inc., Burlington, Mass.

The MA-3470 switches are available as single-pole, single-throw units and operate in the C to X band frequencies (5400 Mc to 9800 Mc).

The switches are designed for applications in which ultra-fast switching (typically two nanoseconds) combined with small size, long life, light weight, rugged construction, and all-solid-state reliability are desired.

A major advantage of the MA-3470 switches is the low driving power required (approximately 75 milliwatts). Insertion loss in the "closed" position is as low as 0.5 db (maximum) and isolation of 20 db is provided in the "open" condition. All three switches will handle 150 watts peak power, and up to four watts CW.

Detailed specifications, price and delivery information are available from the manufacturer.

Circle Reader Service Card 141

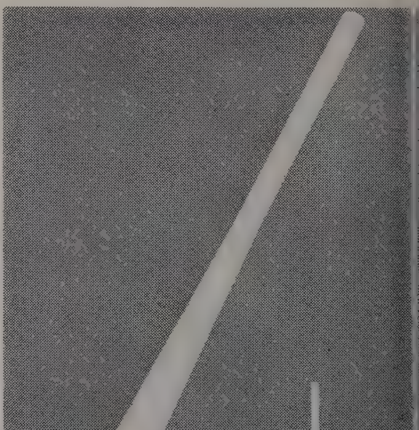
—mwj—

POLYROD ANTENNAS OFFERED BY ATI

Applied Technology, Inc., Palo Alto, Cal., has introduced a line of polyrod antennas exemplified by its Model STP-1.

Featuring a universal ball-joint mounting mechanism, the STP-1 has an advantage over conventional parabolic and horn antennas in that it can be readily mounted and boresighted, thus conserving setup time in site survey or microwave link applications. Also, the small cross-sectional area of the STP-1 minimizes wind loading problems.

Covering the 2.7 Gc to 3.0 Gc frequency range, the STP-1 provides a nominal gain of 15 db with a 3-db beamwidth of about 28 degrees. Polarization is linear. Maximum VSWR is 1.3. A durable white enamel finish weatherproofs the lightweight dielectric radiating element and the holder. Maximum overall dimensions including the mounting mechanism are 29 1/2 inches L x 8 1/4 inches H x 6 1/2 inches W.

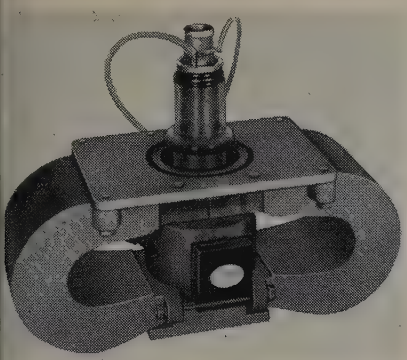


The Model STP-1 is priced at $450 f.o.b. Palo Alto, with delivery in sixty days. Other models, such as the XTP-1 are also available.

Circle Reader Service Card 142

—mwj—

X-BAND PULSED CEM MAGNETRON INTRODUCED BY SFD



The SFD-303, an X-Band pulsed CEM Magnetron has been introduced by SFD Laboratories, Inc., Union, N. J.

The tube, designed for 9375 Mc, operates at over 50 per cent efficiency, delivers a minimum peak power of one megawatt and an average power of one kilowatt, and weighs less than 45 pounds. Operating peak voltage and current are 3 kv and 60 amps.

The design employs a new concept in anode design which permits significant improvements in frequency stability. Typically, side lobe ratios are greater than .0 db, missing pulses less than 0.2 per cent, and a pulling factor of less than six Mc at the megawatt level. At two μsec pulse lengths the RF bandwidth is less than 0.7 megacycles.

The SFD-303 is available 120 days after receipt of order. Tubes of this general class at other power levels and at other frequencies are in development and can be made available in limited quantities in six to nine months.

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—*mwj*—

PAPERS

We wish to emphasize again that "the journal" is interested in receiving papers from the industry.

Papers can be addressed to: "the microwave journal," 1330 Beacon St., Brookline 46, Mass.

—*mwj*—

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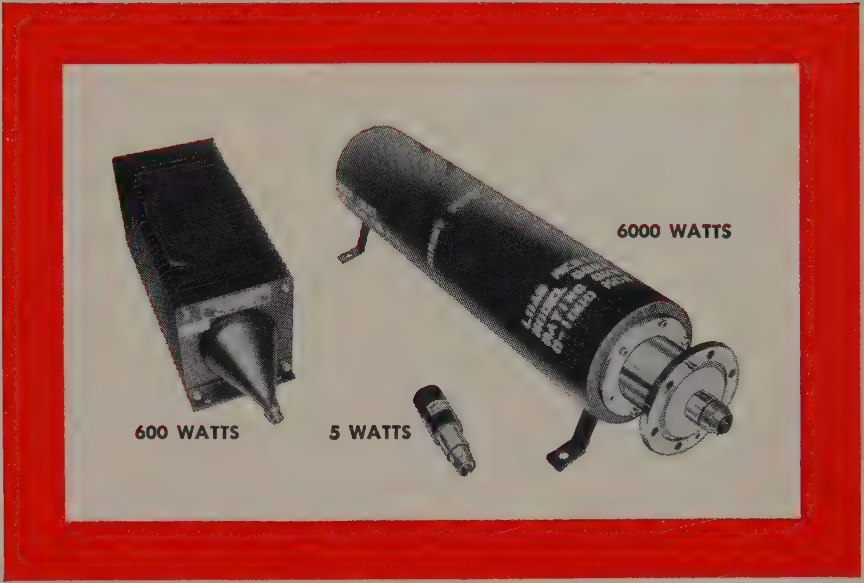
TO 6000 WATTS AND 3000 MCS.



MicroMatch RF Load Resistors provide the virtually reflectionless terminations needed for accurate RF power measurement. They serve many useful purposes as non-radiating RF power absorbers, particularly in lieu of antenna systems during the measurement and alignment phase of transmitter operation.

Other useful functions are in conjunction with feed-through wattmeters to form excellent absorption-type wattmeters, and as a load for side-band elimination filters or high power directional couplers.

SPECIFICATIONS		RF LOAD RESISTORS	
MODEL NO.	FREQUENCY RANGE (mcs)	RF POWER DISSIPATION (watts)	RF CONNECTORS
601	0-3000	5	N, C or BNC
603	0-3000	20	N, C or BNC
633	0-3000	50	N, C or HN
634	0-3000	150	N, C or HN
635	0-3000	200	N, C or HN
636	0-3000	600	N, C or HN
638	0-2000	6000	3⅛″ flange

Many other special models have been designed and manufactured to meet your particular space and input connection requirements.

For more information on RF Loads, Directional Couplers, Tuners, and RF Wattmeters, write:

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EXCLUSIVE COAXIAL GUN DESIGN A NEW HIGH POINT IN ITT IATRON* PROGRAM

Latest additions to the ever-increasing line of ITT Iatron storage tubes are several new models in which both the writing and the flooding guns are symmetrically disposed about the axis of the cathode-ray display tube. This imaginative solution to a difficult packaging problem in radar indicator design eliminates at the same time all possibility of trapezoidal distortion.

Added to the full line of ITT Iatrons with the more conventional off-axis writing gun arrangement, the new coaxial gun models make it possible to specify an ITT Iatron for virtually any storage tube application—in any diameter from 2½ to 7 inches, to satisfy any requirement with regard to weight, size and desired brilliance under high ambient light conditions.

New and further improved ITT Iatrons, in an even wider range of types, are scheduled for release in the near future. ITT's unlimited access to world-wide research, development and production facilities turns a new design concept into a production model at record pace—in Iatrons as well as other electron tube types.

Write for information on the complete line of ITT Iatrons. Application assistance is available for your specific requirements.

ITT IATRON STORAGE TUBES

TYPE	DIAMETER (in.)	SPECIAL FEATURES	FOCUS†	DEFLECTION†
7172	2½	Coaxial gun	ES	ES
FW-211	2½	Coaxial gun	ES	ES
7173	4	—	EM	EM
7174	4	—	EM	EM
FW-227	4	2 writing guns	ES	ES
7423	5	—	ES	ES
FW-204	5	Coaxial gun	EM	EM
D 3001	5	—	ES	ES
FW-212	5	Coaxial gun	ES	ES
FW-223	5	Coaxial gun	ES	EM
FW-208	7	—	EM	EM

†EM = Electromagnetic ES = Electrostatic

ELECTRON TUBE DEPARTMENT ■ COMPONENTS DIVISION
INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION, CLIFTON, NEW JERSEY

ITT COMPONENTS DIVISION PRODUCTS: POWER TUBES • IATRON STORAGE TUBES • HYDROGEN THYRATRONS
TRAVELING WAVE TUBES • SELENIUM RECTIFIERS • SILICON DIODES AND RECTIFIERS • TANTALUM CAPACITORS

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Abstracts from *Russian Technical Literature*. . . of interest to microwave engineers

Translations of complete papers can be made available by contacting Morris D. Friedman, c/o "the microwave journal," 1330 Beacon Street, Brookline, Massachusetts. Prices are dependent upon length of paper.

AN USSR, OTN, EiA, No. 2 (1961)

S. Kalmykova, S. S. Tret'iakova, V. P. hestopalov:

ELECTROMAGNETIC WAVE PROPAGATION IN A MODIFIED CONTRA-WOUND HELIX PLACED IN A CYLINDRICAL WAVEGUIDE.

pp. 159-164

In order to avoid losses by radiation y TWT with contra-wound helices, it s expedient to use a shielding system, e. to place the modified helix in a metal housing. The dispersion and other properties of such a shielded retarding system are investigated herein by using variational method.

KHAR'KOV UNIV. (*7F, 5R*)

[$81.00 — For a custom translation]

— *m w j* —

RT, 16(4) (1961)

M. ZH. Kisliuk:

BENT WAVEGUIDE OF RECTANGULAR CROSS-SECTION.

pp. 3-11

The electromagnetic field configuration in circular bends of rectangular waveguides is analyzed; approximate expressions are derived for the fields in a bent waveguide and so are their propagation coefficients composed of elementary functions which are completely suitable for practical computations.

(*4F, 5R*)

[$100.00 — For a custom translation]

— *m w j* —

ZTF, 31(4) (1961)

S. M. Levitskii, I. P. Shashurin:

METHOD OF THE RESONANT MICROWAVE FREQUENCY PROBE TO MEASURE CHARGE CONCENTRATIONS IN PLASMA.

pp. 436-444

Results are described of experience with a new variation with the microwave frequency method of investigating plasmas which permits local measurement of the charge concentration to be made. To do this, a miniature, oscillating system in the form of a shorted segment of a two-conductor line excited by a special microwave channel is inserted into the plasma. Resonance of the system occurs at a definite charge concentration and it is detected by a change in the SWR in the microwave channel.

It is shown that the electron concentration measured by the microwave probe method in a stationary plasma agrees, to five per cent accuracy, with the concentrations determined by the conventional probe method.

The possibility is verified of using the described probe in a nonstationary and stationary plasma in the presence of a magnetic field.

KIEV UNIV (*7F, 1T, 10R*)

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— *m w j* —

IVUZ, RT, 4(1) (1961)

E. S. Kovalenko, V. S. Kovalenko:

ON THE THEORY OF A DIAPHRAGMED WAVEGUIDE OF RECTANGULAR CROSS-SECTION.

pp. 11-25

Infinite systems of algebraic equations obtained in the theory of a diaphragmed rectangular waveguide are investigated. A method of solution is indicated and an application is given of the results obtained to a numerical computation of the harmonics and edge frequencies of LE and LM modes.

TOMSK POLYTECH. INST.

(*4F, 1T, 6R*)

[$140.00 — For a custom translation]

— *m w j* —

Iu. Ia. Iurov:

COUPLING OF NORMAL MODES IN WAVEGUIDES WITH A FERRITE.

pp. 26-36

Electromagnetic waves in waveguides of arbitrary cross-section containing a ferrite cross-section, magnetized in the longitudinal direction in the transverse plane, are represented by the sum of modes of the empty waveguide and their longitudinal components.

Expressions are obtained for the propagation constants and for the mode amplitudes. A new principle is proposed and realized experimentally, for the transformation of axially-symmetric modes into a linearly-polarized mode by using a ferrite.

LENINGRAD ELECTROTECH. INST.

(*12R*)

[$120.00 — For a custom translation]

— *m w j* —

RiE, 6(4) (1961)

B. E. Kinber:

ON THE SIDE RADIATION OF MIRROR ANTENNAS.

pp. 545-558

A method is explained for the computation of the side radiation of mirror antennas which is based on the use of asymptotic solutions of diffraction problems. It is shown that previous work on the theory of mirror antennas did not take account of a number of essential phenomena and, consequently, gave untrue results in certain cases. Graphs are presented of the envelopes of the side radiation of cylindrical and axisymmetric antennas.

(*17F, 2T, 8R*)

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— *m w j* —

G. P. Samuilov:

ON AN APPROXIMATE COMPUTATION OF THE EIGENVALUES OF HIGHER TYPE MODES IN STRIP LINES.

pp. 579-583

A method is analyzed for the solution of problems on strip lines which is based on the reduction of the longitudinal mode propagation to lateral propagation with the subsequent application of the method of functional equations. Computational and experimental curves of the phase velocity are presented.

(*5F, 1R*)

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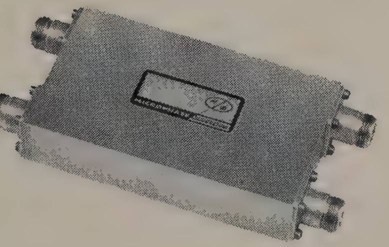
(*Continued on page 137*)

NEW MICROWAVE COMPONENTS from MICROPHASE

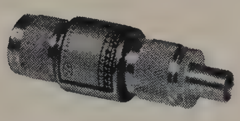
CO-DIRECTIONAL COAXIAL HYBRIDS



Available in	
Frequency Range	750-5000 mc
Usable Bandwidth	25%
20%-Bandwidth Characteristics*	
Power Split	3±0.1 db
Insertion Loss	0.1 db (approx)
Isolation	20 db min
VSWR	1.2:1 max
Connectors	N or TNC

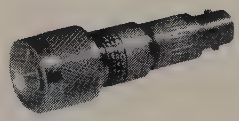
*Wider bandwidths, with comparable characteristics, available on request.

VIDEO DETECTORS



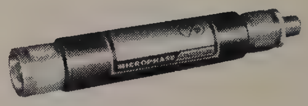
CVA SERIES

Designed for cartridge-type microwave diodes, the CVA-Series video detector-mounts operate over three-octave bandwidths in the 10-mc to 10-kmc frequency range. These improved mounts offer minimum distortion and maximum sensitivity, and are available with or without internal DC return.



CVB SERIES

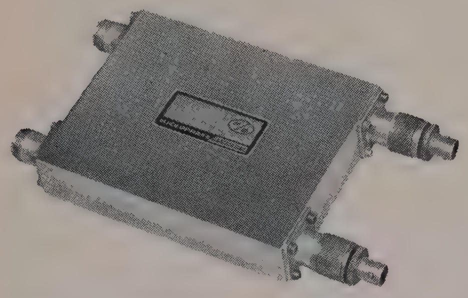
The CVB-Series detectors are designed for standard coaxial diode-cartridges. When used with improved RF diodes, five-octave bandwidths are achieved with better than −45 dbm tangential sensitivity (5-mc video bandwidth). These video detectors are available in the range of 10 mc to 12.0 kmc, with or without internal DC return.



CVC SERIES

The CVC-Series detectors are for applications which require utmost sensitivity. An improvement of 5 to 10 db in sensitivity is realized by a special RF design which compensates for diode impedance-mismatch. These detectors are available covering octave bandwidths of 0.5-1 kmc, 1-2 kmc, 2-4 kmc, and 4-8 kmc. All mounts have internal DC return.

BALANCED MIXERS—CBC SERIES



CBC-Series coaxial balanced mixers are available in the range of 750 to 5000 mc, and are designed to operate over 20% bandwidths. Typical performance of the units is:

Noise Figure	8.0 db (1.5 db IF)
L-O/Signal Isolation	20 db min
L-O Noise Suppression	20 db min
VSWR	1.8:1 max

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(*Continued from page 135*)

A. Malyshev:

ON THE THEORY OF DIODE MICROWAVE GENERATORS.

. 604-612

Within the span of the kinematic apoximation, a theory of diode microve generators is explained and an alysis is given of their operation. A eoretical comparison is made of diode nerators and reflex klystrons by means the output parameters.

(*4F, 10R*)

100.00 — For a custom translation]

— S S J —

L. Igritskii:

COMPUTATION OF PERIODIC ELECTROSTATIC FIELDS ENERATED BY BIFILAR HELICES IN TRAVELING WAVE TUBES

. 613-662

A method is given for the computaon of electrostatic fields in systems ntaining bifilar helices and intended r the periodic electrostatic focussing solid and hollow electron beams in WT. There are made a computation the field within the bifilar helix, a mputation of the field in the annular gion bounded by the conducting cylinr and the bifilar helix, a computation the field in the annular region bound- by two bifilar helices having the me and different spacings.

(*4F, 6R*)

110.00 — For a custom translation]

— *m w j* —

. P. Shestopalov, I. P. Iakimenko:

N THE ATTENUATION OF SLOW LECTROMAGNETIC WAVES IN A LASMA ROD IN THE PRESENCE OF A LONGITUDINAL MAGNETIC FIELD.

b. 653-654

A dispersion equation for a plasma od in a longitudinal magnetic field has een established and investigated without king account of losses. This equation as been obtained again by a passage to e limit from the helix-plasma system the plasma rod. This latter equation ermits the determination of the disperon of slow electromagnetic waves.

HAR'KOV UNIV. (*3F, 2R*)

$20.00 — For a custom translation]

— *m w j* —

G. B. Bogdanov:

ON THE POSSIBILITY OF USING FERRITES FOR THE ABSOLUTE MEASUREMENT OF MICROWAVE POWER.

pp. 663-667

The purpose herein is to determine the properties of a manganese ferrite as a ferromagnetic semiconducting thermistor which could be used for the absolute measurement of microwave power in well-known bridge circuits.

(*4F, 4R*)

[$40.00 — For a custom translation]

— *m w j* —

VMU, Ser. III, FA, No. 2 (1961)

S. K. Lesota:

MEASUREMENT OF THE CORRELATION BETWEEN AMPLITUDE AND FREQUENCY FLUCTUATIONS IN A REFLEX KLYSTRON

pp. 3-8

An interference method used to measure the amplitude and frequency fluctuations in radio-frequency generators is used to investigate the correlation dependence between the amplitude and frequency fluctuations in a three-centimeter band reflex klystron. Experimental graphs are presented for the correlation function for several different values of the voltage on the reflex klystron, corresponding to the domains of generation with maximum generation power.

MOSCOW UNIV. (*8F, 7R*)

[$70.00 — For a custom translation]

— *m w j* —

V. I. Kanavets:

LOCKING OF OSCILLATIONS GENERATED BY A MILLIMETER BAND BACKWARD WAVE TUBE.

pp. 34-40

Results are presented of an experimental study of the locking of the frequency generated by a millimeter band. BWT. The measurements were made by using a two-stage tube. The first stage is a TWT of the centimeter band, the second a BWT. The BWT oscillations were synchronized to the sixth harmonic of the electron sream. Oscillograms have been obtained of the signal of synchronized generation. A spectral analysis has been carried out which shows that a single-frequency region is realized within the synchronization domain. In order to explain the peculiarities of the locking region by using stream harmonics, oscillograms have been obtained of the signal in the synchronization region at the fundamental frequency during delivery of oscillations from the millimeter band generator to the BWT input. The question of the stability of the amplitude of the stabilized signal is analyzed.

MOSCOW UNIV. (*5F, 5R*)

[$85.00 — For a custom translation]

— *m w j* —

VMU, Ser. III, FA, No. 1 (1961)

N. T. Kutsova; V. P. Martynov:

COMPUTATION OF PARAMETRIC AMPLIFICATION IN AN ELECTRON BEAM FOR A GIVEN PUMPING FIELD.

pp. 16-21

The problem is analyzed for the parametric interaction an electron beam modulated in velocity and current density at the frequency ω and the electric pumping field of frequency 2ω. A computation is made of the first harmonic of the electron current density, which represents the amplified signal of frequency ω, in the approximation of the given field which varies in the time with the frequency 2ω. It is shown that the parametric amplification depends on the amplitude of the pumping field and also on the initial phase relations between the pumping field and the amplified signal. Taking the space charge into account leads to regrouping of the beam and to diminution of the first current harmonic.

(*4F, 6R*)

[$60.00 — For a custom translation]

— *m w j* —

RiE 6(2) (1961)

Iu. N. Kazantsev:

ON THE MEASUREMENT OF ATTENUATION IN WAVEGUIDES.

pp. 241-249

A method is proposed for the measurement of attenuation in waveguide elements by determining the standing-wave coefficient in the waveguide in front of the resonator formed by the sample being measured, the iris and the short-circuiting piston at resonance. Circuits are presented of apparatus for the measurement of the attenuation of H_{01} waves in circular waveguides as are also formulas to estimate the errors.

IRE AN USSR

(*6F, 12R*)

— *m w j* —

G. N. Rapoport:

BACKWARD WAVE AMPLIFIER IN THE STRONG REGION.

pp. 261-266

The amplification of signals of finite amplitude by a single-stage O type BWT is investigated on the basis of a numerical solution of the nonlinear equations. It is shown that the nonlinear effects in a BWT are more substantial than in the conventional TWT and, in practice, they exclude the application of weak signal theory to the computation of a BWT power amplifier. Considered briefly are the regions of locking of the selfoscillations by a periodic signal at the BWT input.

(*6F, 7R*)

— *m w j* —

FINANCIAL NEWS

MARTIN EARNINGS INCREASE DURING FIRST HALF OF 1961

The Martin Co., Baltimore, Md., reported net earnings on operations equivalent to $1.56 per share for the first six months of 1961, compared to per-share earnings of $1.24 in the comparable period a year ago.

George M. Bunker, Martin board chairman, announced that total sales amounted to $408,193,230 during the six month period, a gain of more than $106 million from the $301,985,702 during the first half of 1960.

Martin's six month operating statement also listed a profit before taxes of approximately $5,290,000 from the liquidation during the second quarter of the company's investment in the stock of General Precision Equipment Corp.

Sales during the second quarter of 1961 amounted to $210,291,434, up from $161,575,527 during the corresponding period last year. Net earnings on operations for the second quarter of 1961, exclusive of profits from the stock sale, came to 77 cents a share in comparison with 67 cents a share during the comparable period of 1960, an increase of about 15 per cent.

—*mwj*—

AMPHENOL-BORG EARNINGS IMPROVE IN SECOND QUARTER

Consolidated sales of Amphenol-Borg Electronics Corp., Broadview, Ill., were $19,413,496 in the second quarter ended June 30, 1961, compared with $15, 227,558 in the first quarter, Matthew L. Devine, president, reported. Net income was $404,200, or 29 cents a share, compared with $59,270, or 4 cents, in the first quarter.

"The consolidation of the recently-acquired FXR facility into our over-all structure is progressing, and we are making good gains among our domestic and overseas divisions," Mr. Devine said. "Second quarter sales were 27 per cent above the first quarter."

Consolidated sales for the six months ended June 30, 1961 were $34,641,054, compared with $35,226,005 for the like period of 1960. Consolidated net earnings for the 1961 half-year were $463,470, or 33 cents a share, compared with $1,532,948, or $1.10 a share, for the 1960 first-half.

All figures have been adjusted to include FXR, Inc., for all periods. The microwave firm was acquired May 31, 1961.

—*mwj*—

NARDA REPORTS INCREASE IN EARNINGS

A record 87 per cent increase in pe share earnings for the year ended Jun 30, 1961, over fiscal 1960, is indicate in preliminary estimated figures release by The Narda Microwave Corp., Mineol L. I., N. Y. The company is a manufa turer of components and test equipme for microwave and UHF communicatio systems.

On sales (shipments) of $2,645,00 compared with $2,276,000 last year, N da is expected to earn $120,000 or cents a share, compared with $64,000 10.6 cents a share for the like peri ended June 30, 1960, according to Willia A. Bourke, president.

Unaudited sales figures for the thre months ended June 30, 1961, were t highest for any quarter in the company seven-year history—$791,000. The be previous quarter was the comparab period last year, when sales totalin $645,000 were recorded.

Orders for the year just ended totale $2,645,000, compared with $2.229.000 f fiscal 1960; for the quarter ended June 3 1961, orders totaled $827,000, anothe record, topping the previous high $701,000 set in the third quarter of fisc 1961.

—*mwj*—

INDIANA GENERAL REPORTS RECORD EARNINGS

Sales of Indiana General Corp., Va paraiso, Ind., for the first six months o 1961 (ended June 30), increased to $10 250,925, up from $10, 077,824 during th same period of 1960, and were 1.7 pe cent higher than last year, it has bee reported in a letter to stockholders b Mr. Robert F. Smith, president of th company.

Consolidated net income after taxe increased to $770,604 (from $710,19 during the first half of 1960), and wa 8.5 per cent higher, a new record for th period. Net earnings per share amounte to 67 cents during the first half of 196 (62 cents per share in the first six month of 1960).

—*mwj*—

LFE REPORTS ANNUAL SALES FIGURE

Gross income of $50,929,000 for th fiscal year ended April 30, 1961, has bee reported by Laboratory For Electronics Inc., Boston, Mass.

In the company's annual report t stockholders, Henry W. Harding, LF president, said this figure represents a si per cent increase over the previous year' consolidated sales figure of $48,114,000 Combined net income was $1,891,000 u 15 per cent from fiscal 1960's net o $1,648,000.

On the 1,136,636 shares of commo stock now outstanding, this amounts t combined earning's per share of $1.66. O a pre-merger basis, LFE earnings pe share would have been $2.58 compare with fiscal 1960's $2.23 per share.

—*mwj*—

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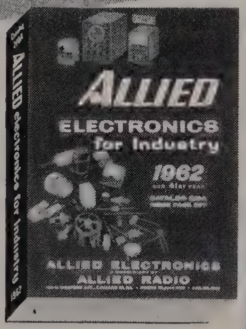

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SCIENTIFIC-ATLANTA REPORTS SALES AND PROFIT GAINS

With a sales increase of 14 per cent nd net profit increase of 24 per cent, cientific-Atlanta, Inc., Atlanta, Ga., has eported record sales and profit results for he fiscal year ended June 30, 1961. Net ales for the year were $2,247,935 and et profit was $130,084, compared with ales of $1,970,879 and profit of $105,018 or the previous year. Net profit was qual to 50c a share compared with 43c share last year.

Glen P. Robinson, Jr., president of the lectronics firm reported unfilled orders nd contracts on June 30, 1961 of $735,-00, which includes $290,000 of a major ubcontract awarded subject to Air Force pproval. The backlog at the comparable ate last year was $560,000.

In commenting on the year's activity, Ir. Robinson noted that the company ontinued its growth trend and increased s net profit margin in a period when any electronic firms were experiencing reduction in profits. Expenditures in upport of research and new product delopment totaled $93,000 for the fiscal ear, with instruments in the antenna test ine and telemetry positioners receiving he major support. Development of equipent for markets outside of the defense arket have received support, with romising results for an expansion of usiness in commercial fields.

— m w j —

RLC ELECTRONICS GETS $100,000 VENTURE INVESTMENT

A $100,000 investment has been made n RLC Electronics, Inc., of Mamaroneck, N. Y., a microwave component firm, by ayson & Trask, venture capital firm of New York, spokesmen of both firms said ast week.

RLC Electronics manufactures preciion coaxial microwave components and ubsystems for communication systems nd laboratory equipment. These units are tilized directly by government agencies s well as manufactured on a subcontract asis for industrial companies. RLC Elecronics is completing its second year of peration and is extensively broadening ts product line.

W. Hardie Shepard, a partner of Payson & Trask, has been elected a director by RLC Electronics.

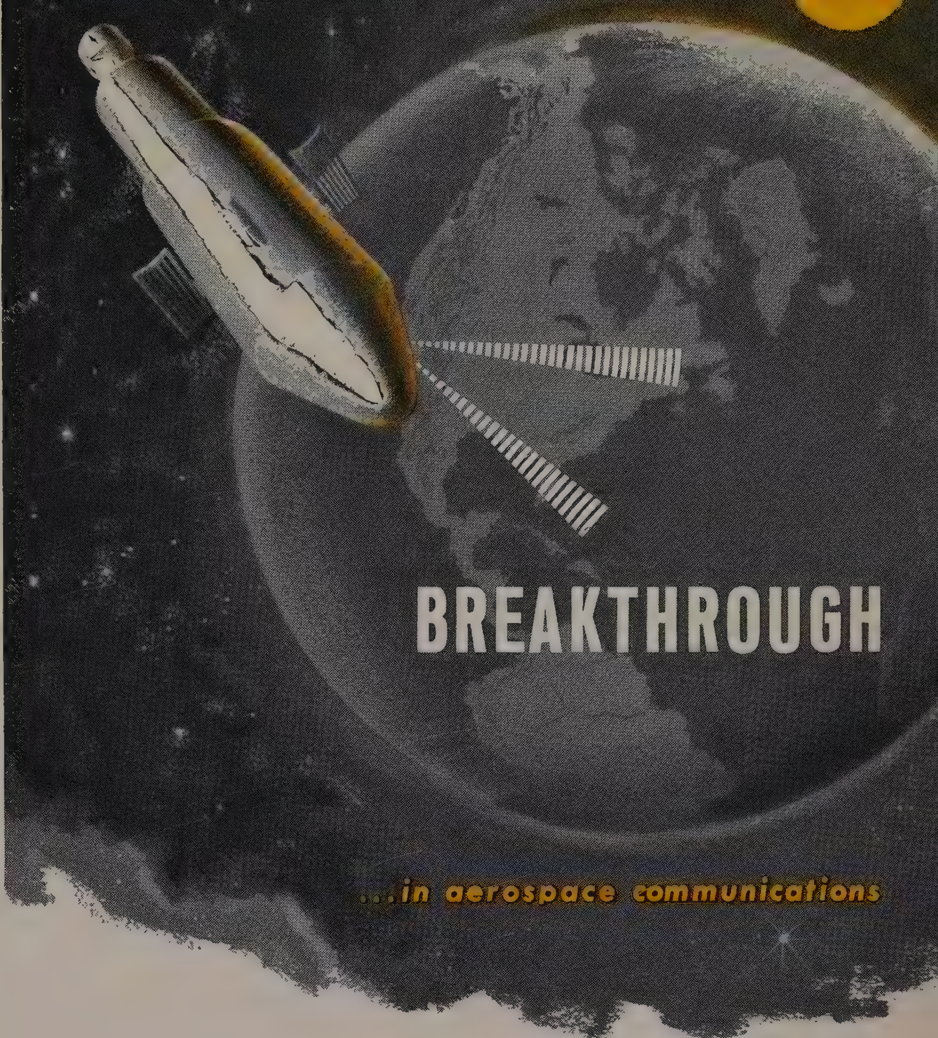
— m w j —

LORAL DOUBLES SALES AND EARNINGS

Loral Electronics Corp., New York, N. Y., more than doubled sales and earnngs for the second successive year, acording to the company's 1961 annual eport.

Net sales for the year ended March 31, 1961, were $35,776,964 compared to $17,439,871 for the previous year. Net inome was $1,301,618 as against $579,216 for fiscal 1960. Per share earnings climbed to 75 cents from 33 cents.

— m w j —



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PAPER ON REQUEST: The paper which explains the new techniques employed in development of the new microwave Solid-State Transmitter authored by W. J. Maciag is available to engineers and scientists on request. Write for the paper entitled "Solid State, S-band Single Side Band Suppressed Carrier Transmitter"

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NEW LITERATURE

TELEMETRY ANTENNA CATALOG PUBLISHED

A telemetry antenna catalog describing over 30 antennas for missile guidance, tracking and telemetry operations has been published by Andrew Corp., Chicago, Ill. in conjunction with its west coast affiliate, Andrew California Corp., Claremont, Cal.

The catalog describes in detail such Andrew designs as the Bifilar Helical and Quad Helix antennas, Helicone and Discone antennas for use in the telemetry and command control frequency ranges. Rotators and other associated accessories are included.

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—mwj—

TECHNICAL DATA SHEET PUBLISHED BY DON-LAN

Don-Lan Electronics Inc., Santa Monica, Cal., has released a new technical data sheet describing their RODOSTUB Coaxial RF Tuners. The data sheet presents photographs and complete specifications on two models which cover frequencies between 0.1 and 10 Gigacycles.

RODOSTUB Tuners are compared with conventional double stub tuners which they replace in microwave system applications. RODOSTUB (ROtary DOuble STUB) tuners require 85 per cent less space than conventional tuners. A section of the data sheet on design and operation describes the patented, rugged (to meet MIL-E-5272) construction and locking device which enable the RODOSTUB Tuner

BOOK REVIEWS

MICROWAVE FERRITES *by P. J. B. Clarricoats; John Wiley & Sons, Inc., 1961.*

"The purpose of this book is two-fold. It aims to provide the microwave engineer first with an introduction to the microwave properties of ferrites, then with a treatment of the theory and principles underlying the operation and design of specific waveguide components employing ferrites." These are the first two sentences in the Author's Preface to this book. The author has accomplished his purpose admirably.

After a brief introduction, the author devotes three chapters to provide a theoretical background for the designer of microwave ferrite devices. The chapter headings are: "General Properties of Ferrites," "Microwave Behavior of Ferrites," and "Loss Mechanisms in Ferrites." To be sure, nothing new is said, but it's nice to have it all in one book instead of scattered through dozens of journals. In these theoretical chapters, it is assumed that the reader has a knowledge of Maxwell's equations, vectors, and tensors.

The chapter on general properties covers magnetic properties in detail, followed by a short but satisfactory explanation of dielectric properties of ferrites. This chapter is a good introduction to magnetism for someone not familiar with the subject.

The chapter on microwave behavior explains the permeability tensor and presents the equation of motion of magnetization in an infinite and in a finite medium. It also covers ferromagnetic resonance in single crystals and polycrystalline materials. The chapter on loss mechanisms also treats single crystals and polycrystalline materials separately.

The next chapter is a long and meaty one entitled, "Propagation through Ferrites and Ferrite Loaded Waveguides." Here the author has treated many different geometries and shows what factors affect propagation. Included are both rectangular and round waveguides, partially filled and totally filled with ferrite. The author discusses ferrite slabs and rods, with and without other dielectrics. This chapter alone is worth the price of the book.

At the end of each chapter there is a list of references covering the material in that chapter. Taken together these references provide a very extensive ferrite bibliography.

All in all, this is an excellent book which belongs in the library of every microwave engineer.

Reviewed by Gershon Wheeler
Editorial Specialist
the microwave journal

—mwj—

BIOLOGICAL EFFECTS OF MICROWAVE RADIATION, *by Mary Fouse Peyton, Ed., Proc. of Fourth Tri-Service Conference, New York Univ. Medical Center, 16-18 Aug. 1960. Plenum Press, N.Y., 1961. 325 pp. + 5 index + viii Paperback.*

This volume contains the papers presented at the fourth annual conference on the biological effects of microwave radiation. The conference was sponsored by the Rome Air Development Center, USAF, and presided over by Col. George Knauf of Patrick AFB. The book opens with a general discussion of the RF environment by Oliver Tallman of RADC; he discusses the danger areas associated with typical high power radars. Papers following are not in an order amenable to review, so the reviewer has taken the liberty of regrouping the papers: they fall into a first group on calculated and measured fields, instrumentation, protective devices, etc.; the second group is concerned with specific biological effects or measurements.

to operate in extreme environments of shock and vibration.

A section on applications covers the fundamental uses of the RODOSTUB tuner to maximize power transfer in coaxial rf transmission lines. This new data sheet should be of particular interest to designers of advanced microwave systems and devices such as up-converters, harmonic generators and other sub-systems which use varactors and filters.

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MICROTECH OFFERS COMPONENTS CATALOG

Microtech, Inc., a subsidiary of Talley Industries, Inc., designers and producers of waveguide components, Cheshire, Conn., has announced a new catalog describing the company's entire product line, now ready for distribution.

The publication, which introduces new and simplified coding and ordering procedures, is especially designed to be suspended on the wall by its open cover, with each page indented and indexed for handy fingertip reference.

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—*mwj*—

CONDENSED CATALOG AVAILABLE FROM SCIENTIFIC-ATLANTA

A 16-page fully illustrated condensed catalog is now available from Scientific-Atlanta, Inc., Atlanta, Ga., manufacturer of antenna instrumentation.

The catalog describes Scientific-Atlanta's one source availability for antenna pattern recording, receiving, transmitting and control equipment, antenna positioners, microwave components, auxiliary equipment, and recorder supplies.

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(*Continued on page 143*)

Two papers concern the calculation of maximum power densities produced by radars, etc. Overman gives quick formulas for safe distance, based on uniform illumination; Englebrecht and Mumford, in a very thorough paper, derive formulas for maximum power density in the radiating near field region from square and round, and uniform and tapered apertures. This paper also includes empirical data on transmission through (or protection by) a wire grid, and a table of safe distances for 46 radar sets. It has since appeared in Proc. I.R.E. In addition to the direct hazards of microwaves, equipment may produce special hazards. The production of hard X-rays by transmitting tubes is discussed by DeMinco, who depicts the expected X-ray regions about typical high voltage microwave tubes. Going from the radiation hazards to experimental investigations, Vogelman discusses instrumentation techniques for irradiating specimens. He recommends a waveguide with iris for exposing appendages or portions of specimens: the guide is matched to reduce reflections with the specimen in place. This is preferable to using an antenna, as far field operation (required for consistent results) is difficult due to the wide dispersal of energy. In an interesting paper, Anne et al investigated the absorption of spheres whose constitutive parameters were similar to those of the human body. Harmonic series calculations were made, followed by anechoic chamber measurements of spherical 'phantoms' with the interesting result that the relative absorption cross section of mankind is near 50 per cent at S-band! (A phantom is an inanimate device which simulates the absorption of an actual specimen.) Finally, Reynolds discusses a shielded suit which allows the wearer to meet the BMEWS radar face on with impunity.

The remaining papers are all concerned with experiment on live specimens. Two papers discuss effects on neural tissue in decerebrated cats (SPCA take note) at 10 Gc. In one of the papers, Fleming et al also describe an indium antimonide radiometer for measuring surface temperature of a specimen under irradiation. Cellular effects claimed much attention, with specimens including the endocrine system of the rat, human gamma globulin, chick embryos, and rabbit eye lenses. Bach et al investigated effects upon gamma globulin in the range 10-40 Mc, and found results unrelated to thermal heating. Some frequencies were ineffective while others seemed to partially unfold the protein helix. The regular spacing of these effective frequencies lends credence to a suspicion that they are harmonics of some key frequency. Shades of Brave New World!

Athermal effects have appeared in a few other cases also. In many cases, however, it appears that the microwaves affect the specimen only in a thermal sense—the heat coagulating or otherwise altering cells. Cellular differentiation in chick embryos is inhibited by S-band radiation. Van Ummersen found that already differentiated structures continued cellular proliferation after irradiation but that no further differentiation occurred. Finally, Saito and Schwan, in a paper on the time constants of pearl chain formation, conclude, after an elegant boundary value transient analysis of two lossy dielectric spheres in a lossy medium subject to an applied field, that pearl chain formation is not an important mechanism in microwave irradiation.

These papers are of value to anyone concerned with radiation hazards and, in fact, to all of us who are worried about our protein helices! The usefulness would have been greatly improved had there been a broad survey paper for non-biologists giving a sketch of the biological results, even results as of last year.

Reviewed By
R. C. Hansen
Associate Editor
the microwave journal

—*mwj*—

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(*Continued from page 141*)

TWO CATALOGS ISSUED BY MDL

A 14-page, two color fully-illustrated talog, FA61-1, from Microwave Develpment Laboratories, Inc., Natick, Mass., sts mechanical specifications for waveuide flanges, including single and dual hoke and cover for both pressure and on-pressure applications. The catalog ncludes a detailed glossary of terms desribing types of flanges, mounting methds and holes.

Tabulated dimensional data on 160 ngle and dual flanges covering EIA aveguide sizes from WR12 to WR2100 re conveniently subdivided by flange tyle and mating waveguide with refernce to both EIA and JAN numbers. Each ble is supplemented by a series of diarams on each page and a cross-reference s made between JAN flange and MDL odel number.

Also a 12-page, two color catalog, IS61, describes in detail more than 100 idewall short-slot hybrids, covering EIA aveguide sizes from WR15 to WR2100. llustrations of various styles and terminations are provided with electrical and echanical data tabulated and subdivided y EIA and JAN waveguide size. Many on- standard waveguide sizes are also ncluded.

Engineering information includes a disussion of hybrid theory, a chart of VSWR vs isolation, as well as an explanation and formula to calculate phase error. Various applications of sidewall hybrids are illustrated through the use of photographs with descriptions.

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WEINSCHEL HEAD REPORTS ON 3-YEAR DEVELOPMENT OF ATTENUATION MEASUREMENTS AND STANDARDS

As a member of Comission I, URSI (International Scientific Radio Union), Bruno O. Weinschel wrote a report on "Development in Attenuation Measurements and Standards." This was part of the United States National Committee Report to the XIII General Assembly held in London September 5-15, 1960.

The report covers the USA progress for the period 1/1/57 to 12/31/59. It defines the terms used in attenuation measurements and discusses new techniques for making insertion loss and attenuation measurements. It has been published in the NBS *Journal of Research*, Vol. 64D, No. 6, Nov.-Dec. 1960 and Vol. 12, Part I of URSI.

Weinschel, a specialist in the microwave precision measurements field, is the President of Weinschel Engineering, Kensington, Maryland, and the author of many professional papers in the field.

Interested persons may request copies by writing to Weinschel Engineering, 10503 Metropolitan Avenue, Kensington, Maryland.

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FOLDER DESCRIBES HIGH POWER EPITAXIAL SILICON VARACTORS

A four-page folder describing 220 new epitaxial silicon high power varactors and providing specific pointers on how to choose the appropriate varactor for best circuit performance is available from Microwave Associates, Inc., Burlington, Mass.

The new types listed in the two-color folder are available in four package styles — subminiature glass case, double-ended cartridge, "pill" case, and "coaxial pill" case — all hermetically sealed — to provide exceptional dimension in RF circuit design.

These high "Q" varactors provide greatly improved power handling capability, simplified RF circuit design, improved circuit reliability, lighter weight plus solid-state compactness and ruggedness in communications and radar equipments.

To simplify diode selection the last page of the flyer provides detailed pointers for calculating the best diode choice for harmonic generator or for modulator applications.

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— *m w j* —

(*Continued on page 144*)

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New Literature

(*Continued from page 143*)

CATALOG DIGEST AVAILABLE FROM POLARAD

A new catalog digest of microwave test instruments is now available from Polarad Electronics Corp., Long Island City, N. Y. Listing applications and specifications of Polarad's complete line of test equipment, the booklet features a new product line of transistorized test instruments including a spectrum analyzer, microwave receiver, microwave impulse generator and calibrated field intensity receiver.

The catalog also describes a library of technical literature that is available as an aid to microwave research and development work.

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— *mwj* —

SEMICONDUCTOR SHORT-FORM CATALOG AVAILABLE FROM MICROWAVE ASSOCIATES

The Semiconductor Division of Microwave Associates, Inc., Burlington, Mass., announces the availability of its new 12-page short-form catalog describing its complete line of microwave semiconductor products.

The latest electrical and mechanical specifications plus outline drawings with dimensions are given for Microwave Associates' varactor diodes, microwave mixer diodes, microwave RF video detector diodes, and RF power monitoring diodes. Included in this latest edition are 220 new high power epitaxial silicon varactors, available for the first time in four case styles — subminiature glass case, double-ended cartridge, "pill" case, and the new "coaxial pill" case.

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— *mwj* —

GE PUBLISHES BULLETIN ON TWT LINE

A 16-page bulletin on General Electric's growing line of low-noise traveling-wave tubes is now available from the company's Power Tube Department, Schenectady, N. Y.

The bulletin includes a basic description of low-noise TWT's design and application information, and technical specifications on seven tube types now available in production or sample quantities.

General Electric low-noise TWTs in production or under development cover S-, C-, X-, K-, K_a- and K_u-bands and feature noise figures of less than 15 db, with the majority of the line having noise figures of 10 db or less. All but one tube in the line is of metal-ceramic construction with permanent-magnet or periodic-permanent-magnet focusing.

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— *mwj* —

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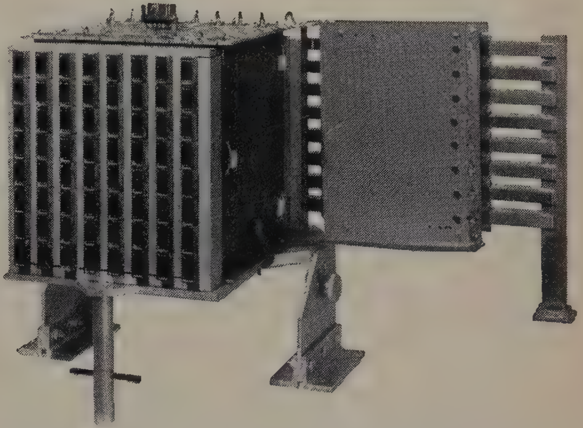

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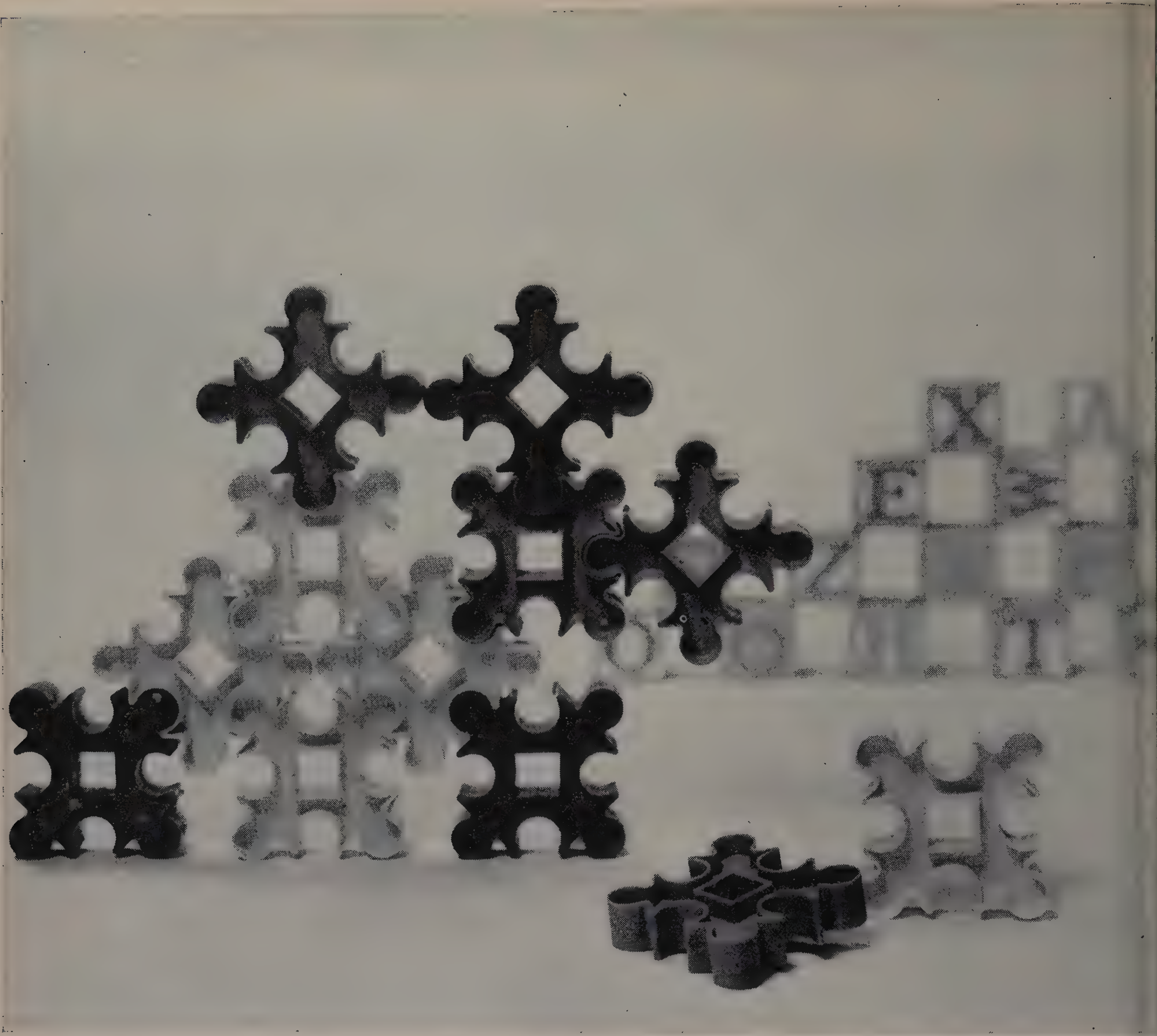

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"ARE ALL THESE PEOPLE NECESSARY?"

GOVERNMENT CONTRACTS AND CLEAR CONSCIENCES

By J. V. N. GRANGER

The readers of this magazine need no reminder of the role which government applied research and development contracting plays in the electronics industry. I am confident, too, that every reader expects, as I do, that the government will continue to be a major factor for years to come. I suspect that a good many will further agree that most government R&D contract programs fall far short of what is desirable, and perhaps vital, in terms of achievement and efficiency, to say nothing of their influence on business policies and procedures or their impact on the profit and loss statement.

The proper planning and conduct of a contract R&D program is a very challenging assignment, and I suspect that most of those who lay claim to a mastery of the art are naive, or lucky, or both. The timely identification of applied research and advanced development needs, the definition of specific objectives, the conception of realistic approaches, cost estimating, technical supervision, the effective communications of progress, the proper evaluation of results — each one of these is a demanding undertaking in itself, and *all* of these are basic to each program. The sum of these jobs is so demanding that total success in any instance is an achievement of major proportions. The simple truth is that unqualified success in a contract R&D program is rare indeed.

One reason the job is so hard is that so many people are required to do it. Operational people, technical specialists, budget planners, contracting officers, legal and patent experts, engineering managers, program administrators, technical writers and a whole list of others. Overlaid on this structure, of course, are the committees — to plan, to coordinate, to allocate, to review, to reorient, to evaluate.

Are all these people necessary? Probably not, but after literally years of consideration of the situation by competent and dedicated people, the net outcome is the proliferation of the system into an almost cosmic manifestation of Parkinson's Law. The real difficulty with having so many people in the act is that the vector sum of their individual contributions is so much like random noise. In other words, each individual involved starts out with a premise which is uniquely his own. His value judgments then, are measured along coordinates which tend to be orthogonal with respect to those of every other individual involved. This is a familiar situation, and not necessarily a bad one. A typical instance of this is very familiar to all of us:

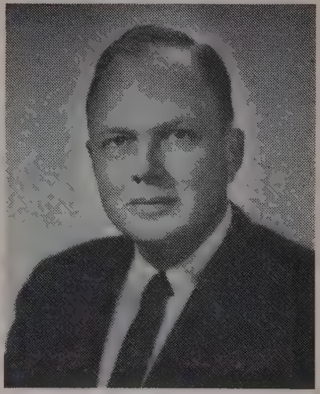
In engineering organizations, the contribution of each individual impacts both laterally and vertically, but in different ways. Someone said once that "engineers formulate problems and managers make decisions," and the

---

DR. JOHN V. N. GRANGER is president and member of the board of directors of Granger Associates, an electronic systems firm located in Palo Alto, California. He earned his AB degree from Cornell College (Mt. Vernon, Iowa) in physics and mathematics and his MS degree in communications engineering from Harvard Graduate School.

Dr. Granger entered Harvard again in 1946 where he earned his PhD in 1948 with a thesis on low frequency aircraft antennas. In April, 1949, he joined Stanford Research Institute, Menlo Park, California, to organize and supervise the antenna research program. He became assistant chairman of the Engineering Division in 1951.

For his achievements, Dr. Granger received the title of "The Outstanding Young Electrical Engineer of 1952," awarded by Eta Kappa Nu. He is a Fellow of the Institute of Radio Engineers, a member of the Board of Directors of the San Francisco Section of the IRE, and a member of the Board of Directors of WESCON.



remark has a certain appeal. In this light then, it is understandable that the effectiveness of the individual is measured by his technical peers, on the one hand, in terms of his insights into the workings of nature; and by his executive supervisors, on the other hand, in terms of the attractiveness of the alternatives for action which his work reveals. The orthogonality which these two measures seem to display, if it's real, would indicate that organizational effectiveness is properly computed in terms of vector products, and not scalar ones.

Whatever form a useful mathematical model of the situation might take, intuition tells us that the question of divergent premises or incompatible value systems is a pertinent one, a situation that needs to be recognized and organized to work for us, or we shall never escape the danger of being done in by a system of our own creation, our Frankenstein's monster.

The basic questions that have to be resolved in the planning and execution of an applied research or advanced development program are pretty simple:

> What are we trying to do?
> How do we know we're making progress?
> How will we know when we've done it?
> Will it matter, anyway?

Of course, by the time we've chased down all the ramifications of each of these questions in any particular instance, and fully explored the divergent opinions that will be available on every point, we may well be more confused than when we started. Healthy confusion, on the other hand, when it's recognized as such, has always been a potent incentive to progress in science, and may be the very stimulant we're looking for.

The starting point of R&D, of course, is recognizing the problem and defining it in meaningful terms. This is the hardest part, and the most important. Recognizing that something we don't have, or some fact we don't know, is both important and attainable is a truly creative thing. When the area of pertinence is the national interest, or even national survival, the task deserves the very best thinking we can do. I was truly shocked to read in the newspaper recently a report (I hope a distorted one) of a speech by a key figure in the military establishment who was quoted as saying that the identification of research requirements was taking up too much of the time of the country's best brains, so that from now on, this kind of thinking would require official authorization from the highest level. Aside from the fascinating, but perhaps diversionary, question that intrudes here about the notion of "authorized thinking," I submit that the problems posed by second-rate minds are usually unsolvable, irrelevant, or trivial and that research applied to these kinds of problems is a foolish waste of resources which are already in short supply.

Even with the best minds involved in defining the problems (maybe "especially" is the better word), the process is extremely susceptible to a debilitating attack from a disease which is endemic wherever technical work is done — the temptation to confuse the problem with the solution. The human urge to rise to the demands of the occasion, is the almost irresistable impulse which drives people confronted with a new problem to invent a solution to it. The observed fact that this kind of brainstorming is most frequent when the problem is least understood is simply evidence of the well-known depressant effect of understanding.

The problem of measuring progress in R&D work has no easy answer. Progress is relative and progress is timely. We must ask constantly, "Is it true?" and "Is it pertinent?" In R&D so many of the apparent facts or solutions are in error or are true but irrelevant, but are nonetheless fascinating, that the temptation to stray from the path of righteousness is a mighty one. In military R&D, the question of timeliness is always basic. An answer discovered too late is no better than a wrong answer. The "scheduled technological break through" is a naive concept, but a good guess in time is infinitely more important than a demonstrable certainty arrived at after the time for decision has passed.

Knowing when to quit is perhaps the least common of technical skills. Everyone knows that using up all the money never stopped an R&D man. In my experience, the only way to stop one is to start him on something new, but the trouble I have deciding when that should happen is typical. It would not surprise me in the least to learn that somewhere someone is industriously occupied in improving the designs of buggy whips .

Out of my own R&D experience, I have evolved an approach which I am convinced is a very sound one, though I have had very little success in convincing other people that I'm not being facetious. My formula for effective conduct of applied research is this: Write the final report before you do anything else. This is the only sure way I know to discover what it really is that you are doing research on — what significant facts have to be determined, and how accurately. In R&D there is always a great temptation to gather more and more data. In fact, the R&D community has invested a prodigious amount of effort in developing schemes for gathering data. In some areas, we've succeeded in automating the process. The shortcoming of this should be obvious: it's not more data that is needed, it's more pertinent data, and no one has succeeded in designing a lab instrument that's capable of making the distinction. In fact, we too seldom are capable of making the distinction ourselves.

Is government R&D worthwhile, after all? Are we accomplishing something that is important; more important than the alternatives; worth the trouble, the frustration, and the money? Or are we, rather, ascribing merit to a compulsive drive to justify ourselves and lend stature to our positions? These questions are as pertinent as any we can ask, and we owe ourselves and our nation a sincere and thoughtful answer. My own answer is that applied research and advanced development for government *can* be worthwhile, and sometimes *is* worthwhile. However, to be satisfied with it as it is, is to fail the challenge to make it better, and makes a mockery of those elements of character, of dedication to science, which are so closely identified with our national genius and our professional pride.

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- 9-65 ☐ Detection
- 7-65 ☐ Tracking
- 0-66 ☐ Tropo Scatter
- 1-66 ☐ Airborne
- 3-66 ☐ Other ______________ Type

0-67 ☐ **TEST EQUIPMENT**
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7-67 ☐ **TUBES**
- 9-67 ☐ Planar
- 0-68 ☐ Passive devices
- 7-68 ☐ Storage
- 1-68 ☐ Klystron
  - 3-68 ☐ High power
  - 5-68 ☐ Low power
- 9-68 ☐ Gaseous discharge
- 9-69 ☐ Duplexers
- 7-69 ☐ Crossfield
- 1-69 ☐ BWO
- 8-69 ☐ TWT
  - 9-83 ☐ High power
  - 9-84 ☐ Low power
- 0-69 Magnetron
  - 9-81 ☐ High or 9-82 ☐ low power
- 5-69 ☐ Other ______________ Type

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- 3-70 ☐ Amplifiers
- 5-70 ☐ Transistors
- 7-70 ☐ Paramagnetic
- 9-70 ☐ Thermoelectric
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- 0-72 ☐ Ferrimagnetics
- 1-72 ☐ Parametrics
- 0-71 ☐ Ferrites ______________ Type
- 3-72 ☐ Crystals
- 5-72 ☐ Infrared
- 7-72 ☐ Other ______________ Type

3-73 ☐ **TRANSMISSION LINES**
- 7-73 ☐ Coaxial
- 9-73 ☐ Waveguide

0-74 ☐ **SMALL COMPONENTS**
- 1-74 ☐ Bolometers
- 3-74 ☐ Holders & Mounts
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  - 7-76 ☐ Waveguide
- 3-75 ☐ Filters
- 5-75 ☐ Attenuators
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- 0-76 ☐ Terminations
- 1-76 ☐ Other ______________ Type

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- 9-86 ☐ Packaging
- 0-87 ☐ Dielectrics
- 1-87 ☐ Absorbers
- 3-87 ☐ Other ______________ Type

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- 9-87 ☐ Germanium
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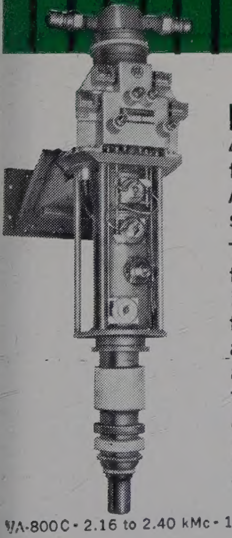

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The first link in Ace High, a four-station system called Hot Line, was installed in Norway in 1958. Varian's VA-800C amplifier klystrons are the heart of the system. Tube life to date is averaging over 5,000 hours. What's more, the average improves every day; two-thirds of the tubes are still operational. In fact, two tubes are over 13,000 hours.

Do you require such exemplary tube performance? Technical data? Just write Tube Division.

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ANOTHER ADVANCED MICROWAVE TUBE DEVELOPMENT
FROM RAYTHEON'S SPENCER LABORATORY

BACKWARD WAVE
OSCILLATORS
"O" TYPE
RAYTHEON
QKB

K-BAND BWO, QKB 891, of a completely new design is extremely rugged and compact.

New K-band O-type BWO's extend Raytheon compatible line to 26.5 kMc

Advanced design provides 40 mW minimum power output in extremely rugged and compact package.

Size and weight of these two new Raytheon backward wave oscillators are barely half that of units now in use.

The QKB 890 and QKB 891 are designed for such applications as swept local oscillators in ECM receivers and test equipment, driver tubes in frequency diversity radars, and pump tubes for broadband parametric amplifiers. Both tubes utilize PM focusing and have grids for low-voltage pulsed operation. For equipment designs requiring close mounting, only two-inch spacing between tubes is necessary.

Write today for detailed technical data or application service to Microwave and Power Tube Division, Raytheon Company, Waltham 54, Massachusetts. In Canada: Waterloo, Ontario.

TYPICAL OPERATING CHARACTERISTICS

	QKB 890	QKB 891
Frequency Range	12.4-18 kMc	18-26.5 kMc
Power Output	40-180 mW	40-180 mW
Delay Line (tuning)	400-1270V	600-2100V
Anode Voltage (fixed)	125V	150V
Cathode Current	17-21 mA	21-32 mA
Filament Voltage	6.3 Volts	6.3 Volts
Waveguide Coupling	RG91/U	RG53/U

RAYTHEON

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MICROWAVE AND POWER TUBE DIVISION